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A STUDY OF 20 CASES OF FRACTURES OF THE DISTAL FEMUR MANAGED WITH LESS INVASIVE SKELETAL STABILIZATION SYSTEM [LISS] USING LOCKING COMPRESSION PLATE [LCP]

DISSERTATION SUBMITTED FOR
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MADURAI.

CERTIFICATE

This is to certify that the dissertation entitled **"A STUDY OF 20 CASES OF FRACTURES OF THE DISTAL FEMUR MANAGED WITH LESS INVASIVE SKELETAL STABILIZATION SYSTEM [LISS] USING LOCKING COMPRESSION PLATE [LCP]"** is a bonafide record of work done by ***Dr. P. BALAMURUGAN*** in the Department of Orthopaedics and Traumatology, Government Rajaji Hospital, Madurai Medical College, Madurai, under the direct guidance of me.

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DECLARATION

I **Dr. P. Balamurugan,** solemnly declare that the dissertation entitled "**A STUDY OF 20 CASES OF FRACTURES OF THE DISTAL FEMUR MANAGED WITH LESS INVASIVE SKELETAL STABILIZATION SYSTEM [LISS] USING LOCKING COMPRESSION PLATE [LCP]"** has been prepared by me under the able guidance and supervision of my guide **Prof. M. Chidambaram, M.S.ORTHO., D.ORTHO., Prof & HOD,** Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, in partial fulfillment of the regulation for the award of **M.S. (ORTHOPAEDIC SURGERY)** degree examination of The Tamilnadu Dr. M.G.R. Medical University, Chennai to be held in March 2008.

This work has not formed the basis for the award of any other degree or diploma to me previously from any other university.

Place : Madurai

Date :

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CONTENTS

INTRODUCTION

Increased incidence of Road Traffic Accidents, natural disasters, industrial accidents claim most of human mortality and morbidity. Hence, it forms the major epidemic of Modern Era. Of these, fractures of distal femur have historically been difficult to treat. In this modern era of increasing life expectancy, there is a rise of old age population which, increases the incidence of these fractures in osteoporotic bones, adding to the morbidity.

Because of the proximity of these fractures to the knee joint, regaining full knee motion and function may be difficult. Soft tissue damage, comminution, fracture extension into the knee joint and associated injury to the quadriceps mechanism lead to unsatisfactory results in many cases regardless of the treatment modality.

Better understanding of the injury patterns, availability of better implants, the concept of early surgical fixation and early postoperative mobilization of knee joint all have convincingly improved the functional outcome of the patient to a large extent.

A recent advance in technology for the treatment of distal femoral fractures include the less invasive skeletal stabilization system (LISS) and the locking compression Condylar plates (LCP). They offer multiple points of fixed angle contact between the plate and screws in distal femur (Angle stable construct), reducing the tendency for varus collapse and at the same time afford better stability.

The successful management of these injuries, demands thorough knowledge of fracture personality, technical aspects of fracture fixation and the tailored post operative management.

HISTORICAL REVIEW

During the past two decades, the management of supracondylar fracture has advanced greatly.

In the 1930’s MAHORNER and BRADBURN reported unsatisfactory results with Russel traction.

In 1945 FUNSTEN and LEE observed that fracture of distal 1/3 healed sooner than middle (or) proximal third.

In 1951 DELOROME and WEST suggested fibrosis after trauma as the prime cause of knee stiffness.

In 1950’s WATSON and JONES, WHITE and RUSSIN and Sir JHON CHARNLEY recommended non-operative treatment.

In 1965 MULLER suggested L shaped compression plate.

In 1968 RUSH used straight intramedullary rods.

In 1968 VESELY D.G. used single (or) double split diamond nail by bifurcating the distal end.

In late 1960’s NEER’s classification came into vogue.

In 1970 MOONEY advised cast brace traction.

The AO groups were the one to popularize surgery in early 1970's. In 1971 STATIS was the first to use condylar blade plate.

BROWN and BENUM also reported good results.

In 1974 SCHATZKER reported good results with operative treatment method.

In 1971 ROBERT ZICKEL designed Zickel Nail.

In 1979 ZIMMERMAN used DHS for distal femur fracture.

In 1983 KOLMERT introduced semielastic devices consisting of intramedullary elastic nails.

In 1986 REGAZONNI, RUEDI and ALLGOWER – used the Dynamic condylar screw implant system for fractures of the distal femur, for the first time and reported excellent results.

In 1989 STRAUMANN A.G. WALDERNBERG, studied and showed satisfactory results with A.O. Dynamic condylar screw.

In 1990 A.O modified MULLER's classification.

In 1991 GREEN S, SELIGSON D, HENRY SL TRAGER S, primarily used GSH supracondylar nail (retrograde Interlocking nailing) the search was going on for a better implant, to tackle intraarticular and comminuted fractures.

In 1991 SANDERS. R. SWIONTKOWSKI used double plating for comminuted, unstable fractures of distal femur.

In 2000 LCP was approved as new AO standard Plate.

In 2001 KREGOR P.J. STANNARD J., ZLOWODZKI. M. reported early results with L.I.S.S for distal femoral features.

In 2003 FRIGG. R. published an article about the "Development of the locking compression plate".

In 2003 SOMMER C, GAUTIERE, MULLER M, HELFET DL, WAGNER reported first clinical results of the locking compression plate.

In 2005 SEAN E. WORK, DANIEL N., studied association between supracondylar- Intercondylar distal femur fractures and coronal plane fractures.

In 2006 HEATHER A., VALLIER reported failure of LCP condylar plate fixation in the distal part of the femur in selected cases.

ANATOMY OF DISTAL FEMUR

The supracondylar area of femur is defined as the zone between the femoral condyles and the junction of metaphysis and femoral shaft. It comprises the distal 9 cm of femur as measured from articular surface. So the lower end of femur consists of both the region of condyles and the region of supracondylar area.

The femur’s distal end is widely expanded as a bearing surface for transmission of weight to the tibia and has two massive condyles, which are partly intraarticular. Anteriorly the articular surface of two condyles unites to form a surface for articulation with patella. Posteriorly they are separated by a deep inter condylar fossa. The patellar surface extends anteriorly on both condyles but largely the lateral. The tibial articular surface is divided by the intercondylar fossa and is continuous anteriorly with the patellar surface.

The lateral condyle is flat and less prominent more massive, more in direct line with femoral shaft, hence transmits more body weight to the tibia. Its most prominent point is the lateral epicondyle. A short groove separates lateral epicondyle posteriorly from the articular margin. The fibular collateral ligament is attached to the lateral epicondyle. Just above this, an impression gives attachment to the lateral head of Gastrocnemius. There is a separate groove for the attachment of popliteus.

The medial condyle is longer than the lateral condyle. It extends further inferiorly. Its medial surface is convex and is called as medial epicondyle. The medial epicondyle gives attachment to the tibial collateral ligament. Situated in the uppermost part of the condyle is Adductor tubercle on which the tendon of Adductor magnus gets inserted.

The Intercondylar fossa separates the two condyles distally and behind. It is intracapsular but is largely extrasynovial. The fossa’s lateral wall, the medial surface of lateral condyle, has a flat impression for the attachment of anterior cruciate ligament. The medial wall, the lateral surface of medial condyle bears a similar large area for the attachment of posterior cruciate ligament. The fossa is limited anteriorly, by patellar surface and posteriorly by Inter condylar line, which gives attachment to capsular ligament and oblique popliteal ligament. The fossa’s anterior border gives attachment to the Infrapatellar synovial fold.

The supracondylar area contains the lateral and medial supracondylar line which are continuous with linea aspera and a popliteal surface and an anterior surface. The lateral supracondylar line is most distinct in its proximal two – thirds, where the short head of Biceps and lateral – intermuscular septum are attached. The distal third has small rough area for plantaris. The medial supracondylar line is indistinct in its proximal two – thirds, where it gives attachment to vastus medialis and it is being crossed by the femoral vessels entering popliteal fossa. It is sharp in its lower third where it gives attachment to the membranous expansion of tendon of the Adductor Magnus.

The popliteal surface forms the proximal floor of popliteal fossa and is covered by variable amount of fat separating the artery from bone. It gives attachment to medial head of Gastrocnemius and Semimembranosus on its medial side and the lateral surface gives attachment to plantaris.

The anterior surface gives attachment to the intermuscular septae which are attached to the lips of the linea aspera and the supracondylar lines. They separate the extensor muscles from the adductors medially and from the flexors laterally.

NUTRIENT ARTERY TO FEMUR

This is derived from the second perforating artery. Nutrient foramen is located on the medial side of the linea aspera and is directed upwards. The lower end has abundant blood supply through genicular vessels.

The lower end ossifies from a single secondary centre appearing at the end of 9^{th} month of – intrauterine life and it gets fused with the shaft by the age of 20. The lower end of femur is the growing end.

The lower end of femur is having a lot of applied anatomical importance.

1) Medico legally ossification of lower end of femur is very important. Presence of its centre in a newly born child found dead indicates the child was viable and capable of independent existence.
2) The epiphyseal line is at the level of adductor tubercle. Hence intervention here may damage the distal epiphyseal cartilage in children and may entail subsequent shortening of limb.

BIOMECHANICS OF DISTAL FEMUR

The expanded femoral and corresponding tibial condyles are adopted for the direct downward transmission of weight. During weight bearing the two condyles rest on the horizontal plane of tibial condyles and the shaft of femur inclines downwards and inwards.

The longitudinal axis of the diaphysis of the femur inclines medially downward, with an angle of 9° from vertical. The Mechanical axis of the femur formed by a line between centres of Hip and Knee joint is 3° from vertical. Therefore the long axis of the shaft of femur is inclined at an angle to the long axis of the shaft of tibia. This tibiofemoral shaft angle is called as the physiological valgus.

In the sagittal plane, the femoral condyle have a changing radius which decreases from before back. In the transverse plane the condyles diverge from before back by an angle of 20°.

The axis at which flexion and extension occur shifts backwards in relation to tibia with increasing flexion. However it lies approximately along the line joining the femoral epicondyles.

The knee joint possesses features characteristic of both hinge and pivot joint articulation. The joint permits flexion and extension in the sagittal plane and some degree of rotation when the joint is flexed. The complex Flexion – Extension motion is a combination of Rocking & Gliding movement. During Rotatory motion the medial condyle describes a smaller arc than the lateral condyle

The natural deflection outwards of the tibia on femur at the knee joint produces greater weight bearing stresses on lateral femoral condyle than on medial condyle, but because the medial condyle is prolonged further forward than the lateral condyle, the vertical axis of rotation falls in a plane nearer the medial condyle.

The medial & lateral condyles have different configurations. The lateral condyle is broader in the anteroposterior and the transverse planes and the medial condyle projects distally to a level slightly lower than the lateral condyle. This distal projection helps to compensate for the inclination of mechanical axis in erect position, so that the transverse axis is horizontal. The articular surface of the medial condyle is prolonged anteriorly and as the knee comes into the fully extended position, the femur internally rotate until the remaining articular surface on medial condyle is in contact. The posterior portion of lateral condyle rotates forward laterally thus producing screwing home movement, locking the knee in fully extended position.

The surgical anatomy of distal femur is so complex and can present serious problem to the unwary surgeon. When viewed in cross section, the shape resembles a trapezoid with the medial side inclined about 25^0 and the lateral about 10°. The posterior diameter is longer than anterior therefore a screw which appears which appears to be just the right length on an anteroposterior X-ray, is too long and will penetrate the cortex and protrude deep to the MCL. The anterior surface slopes downwards to the medial side and corresponds in inclination to the patellofemoral joint. When the distal femur is viewed from the side, the condyles appear to have been added posteriorly to the shaft. Therefore for the purpose of internal fixation, any device must be inserted into the middle of the anterior half of the condyles. The human femur is the longest bone in the human body and is capable of bearing loads of considerable magnitude. When the structural integrity of the femur is compromised by a fracture of either high or low energy, it can pose a significant surgical challenge to treat. Not only these fractures are articular in nature – occurring in close proximity to the knee joint – but they are often very complicated breaks, resulting in many fragmented segments of bone that serve zero structural support to the femoral construct.

CLASSIFICATION OF DISTAL FEMUR FRACTURES

Essentially all classification put forward for supracondylar and intercondylar fractures distinguish between Extra articular, Intra articular and isolated condylar lesions, which are further subdivided according to the degree and direction of displacement, amount of comminution and involvement of joint surface.

Classification system used for fractures of Distal femur include NEER's classification, STEWART's classification, SCHATZKER's classification, SEINSHEIMER's classification, MULLER's classification and AO classification.

The MULLER's classification is the one which is probably the most widely accepted classification of supra condylar fractures and it was being adopted and modified by the AO group.

NEER'S CLASSIFICATION

Type – I - Non displaced or minimally displaced fractures.

Type – II	-	Displaced fractures
II(A)	-	Medial Displacement of Condyles.
II(B)	-	Lateral Displacement of Condyles.
Type – III	-	Combined Supracondylar and intercondylar fracture.

SEINSHEIMER'S CLASSIFICATION

Type 1 : Nondisplaced fracture or those with less than 2 mm of displacement

Type 2 : Fractures involving the distal metaphysis only, Without intraarticular extension.

a) Two part b) Comminuted

Type 3 : Fractures involving the inter condylar notch in which one or both condyles are separate fragments.

a) medial separate

b) lateral separate

c) both condyles separated from the shaft and from each other.

Type 4 : Fractures extending through the articular surface of a femoral condyle.

a) through medial condyle (two part or comminuted)

b) through lateral condyle (two part or comminuted

c) Complex and comminuted

MULLER'S CLASSIFICATION:

A - Femur distal, Extra articular fracture

- A1 - Simple
- A2 - Metaphyseal wedge
- A3 - Metaphyseal complex

B - Femur Distal Condylar, Partial articular fracture.

- B1 - Lateral Condyle fracture, Sagittal
- B2 - Medial Condyle fracture, Sagittal
- B3 - In coronal plane (Hoffa's fracture)

C - Femur Distal, Complete articular fracture

- C1 - Articular simple, Metaphyseal simple T or Y shaped fracture.
- C2 - Articular simple, Metaphyseal Multifragmentary with 2 Principal articular fragments.
- C3 - Both articular and metaphyseal Multifragmentary (Intraarticular comminution)

AO Classification of fracture of the femur (Distal Femur)

Type A	A1	-	Simple Fracture
	1.1	-	Avulsion fracture of medial (or) lateral epicondyle.
	1.2	-	Fractures of Metaphysis, oblique (or) spiral.
	1.3	-	Fractures of Metaphysis, Transverse.
	A2	-	Metaphyseal wedge fractures
	2.1	-	Wedge intact.
	2.2	-	Lateral Multifragmentary wedge.
	2.3	-	Medial Multifragmentary wedge.
	A3	-	Complex metaphyseal fracture.
	3.1	-	with split intermediate segment.
	3.2	-	Irregular, Limited to metaphysis
	3.3	-	Irregular, Extending into diaphysis.
Type B		-	Fractures are partial Articular
	B1	-	Lateral condylar fracture in sagittal plane.
	1.1	-	Simple through intercondylar notch
	1.2	-	Simple through weight bearing surface.
	1.3	-	Multifragmentary.
	B2	-	Medial condylar fractures in sagittal plane.
	2.1	-	Simple through the intercondylar notch.
	2.2	-	Simple through weight bearing surface.
	2.3	-	Multifragmentary.
	B3	-	Frontal plane fracture.

	3.1	-	Flake fracture anterior & lateral
	3.2	-	Posterior unicondylar.
	3.3	-	Posterior bicondylar.
Type C		-	Fractures are complete articular
	C1	-	Simple fracture of both articular surfaces & metaphysis.
	1.1	-	Slightly displaced T (or) Y fracture
	1.2	-	Markedly displaced T (or) Y fracture
	1.3	-	Distally situated T fracture with the horizontal element involving diaphysis.
	C2	-	Simple fractures of articular surface Multifragmentary of metaphysis.
	2.1	-	With intact wedge
	2.2	-	Multifragmentary wedge.
	2.3	-	Complex.
	C3	-	Multifragmentary of both metaphysis and articular surface.
	3.1	-	Metaphyseal wedge with multifragmentary articular.
	3.2	-	Multifragmentary metaphysis with multifragmentary articular.
	3.3	-	Multifragmentary articular and metaphysis extending into the shaft.

Descriptive Classification

- Open Vs Closed
- Location - supra condylar, inter condylar involvement
- Pattern - spiral, oblique, or transverse
- Articular involvement or not
- Angulation - Varus, valgus or rotational deformity
- Displacement - Shortening or translation
- Comminution, Segmental or butterfly fragment

MECHANISM OF INJURY

The Mechanism of injury in most supracondylar fracture is thought to be axial loading with Varus, Valgus and Rotational forces.

In younger patients, the injury typically occurs after high energy trauma related to motor vehicle (or) motorcycle accidents. In such patients, there may be considerable displacement, comminution, open wounds, and associated injuries. In elderly patients, fractures frequently occur after minor slip and fall on flexed knee, leading to comminuted fracture in compromised osteoporotic Bone.

The deformities that result from supracondylar femoral fractures are produced primarily by the direction of the initial fracture displacement and secondarily by the pull of thigh muscles. The typical varus deformity is usually the result of strong pull of adductor muscles. Contraction of Gastrocnemius produces posterior angulation of distal fragment. Spasm & irritability in the Quadriceps & hamstring usually lead to limb shortening & angulation at the fracture site. In fractures with intercondylar extension, muscle attachments to the respective femoral condyles tend to produce splaying and rotational malalignment which contributes to joint incongruity.

INVESTIGATIONS

Clinically the patients may present with symptoms and signs either of supracondylar fractures (or) other major problems like hypovolemic shock.

All patients with fracture lower end of femur should be looked for peripheral pluses.

A good quality X ray in two perpendicular views is a must to look for the subtype of Muller's classification.

- Computer tomography portrays the distal femur in cross-section, which helps to identify fracture lines in the frontal plane. Two and three dimensional reconstructions may also improve understanding of the fracture pattern in preparation for surgery.

PRINCIPLES OF MANAGEMENT

There are a lot of factors which play a dynamic role in management. They include.

1. Amount of fracture displacement
2. Degree of comminution
3. Extent of soft tissue injury
4. Associated Neurovascular injuries
5. Magnitude of joint involvement
6. Degree of Osteoporosis
7. Associated injuries
8. Complex ipsilateral fractures (eg patella/plateau fracture)

So the objective of treatment of fracture of lower end of femur are

1. To obtain and maintain satisfactory reduction and stable fixation.
2. To regain a functional range of motion of knee joint
3. To regain normal strength of quadriceps and hamstring muscles.
4. To treat the associated injuries.

METHODS OF TREATMENT

In the decade of 1960s, conservative treatment methods such as traction and cast bracing, produced better results than operative treatment, because of the lack of adequate internal fixation devices. With the development of improved internal fixation devices, treatment recommendations begin to change in 1980s. The blade plate designed by the AO group was one of the first used implant and gain wide acceptance for treatment of fractures of the distal femur. As it was technically demanding, a less technically demanding Dynamic Condylar screw was introduced. Those fracture for which both Dynamic Condylar screw & Condylar Blade Plate could not be used remained a problem which was sorted out by the introduction of Condylar Buttress plate. The intramedullary nailing were used in the treatment of distal femoral fractures, because they obtained more biological fixation. Nails have been designed specifically for retrograde insertion through intercondylar notch for the treatment of supracondylar and intercondylar femoral fractures. Flexible intramedullary implants like Zickel's supracondylar device, Ender rods, Rush rods have been used with some success to treat distal femoral fractures. External fixation was used as either temporary (or) definitive fixation in severe open distal femur fractures especially those associated with vascular injury.

A recent advance in technology for the treatment of distal femoral fractures includes the less invasive skeletal stabilization system (LISS) and the locking compression Condylar plates (LCP). They offer multiple points of fixed angle contact between the plate and screws in distal femur (Angle stable construct), reducing the tendency for varus collapse and at the same time afford better stability.

So management of distal femur fracture can be divided into two broad categories.

1. **conservative treatment**
2. **operative treatment**

In operative treatment, various modalities include

1. Open Reduction Internal Fixation with Dynamic Condylar screw
2. Open Reduction Internal Fixation with Condylar blade plate
3. Open Reduction Internal Fixation with Condylar Buttress plate
4. Open Reduction Internal Fixation with Cancellous screws
5. Closed reduction & internal fixation with antegrade locking nails.

6. Closed Reduction & Internal Fixation with supracondylar nail.
7. Closed Reduction & Internal Fixation with flexible intramedullary nail.
8. Ilizarov ring fixation
9. External fixation.
10. Less invasive skeletal stabilization system (LISS) using locking compression plate. (LCP)

CONSERVATIVE MANAGEMENT

Considerable controversy existed as to whether conservative (or) surgical treatment leads to better results for management of distal femur fracture. Early attempts at internal fixation of these complex injuries were associated with high incidence of malunion, nonunion and infection. Because of the increased risk of complications, numerous authors concluded that closed methods were preferable to operative treatment.

With the improvement in surgical techniques, availability of better implants, prevalence of better antibiotics, the conservative management has become almost not applicable for fracture of lower end of femur. In this modern era of fracture management, there is no single absolute indication for conservative treatment. The relative indications for conservative therapy include.

1. Non displaced (or) Incomplete fractures.
2. Impacted stable fracture in elderly osteoporotic patients.
3. Lack of modern internal fixation devices.
4. Unfamiliarity or inexperience with surgical techniques.
5. Significant underlying medical disease.
6. Advanced osteoporosis
7. Spinal cord injury with fractures.

The goals of conservative treatment are not anatomical reduction of fracture fragment but restoration of overall length and axial alignment. The criteria’s for acceptable fracture management include

1. $< 7^{0}$ malalignment in frontal plane.
2. $< 10^{0}$ malalignment in sagittal plane
3. Limb shortening < 1.5 cm.
4. Articular incongruity < 2 mm

Various methods of conservative management include

1. Two pin method of skeletal traction – One through upper tibial and other through lower femoral pin.
2. Skeletal traction with single pin followed by cast immobilization.
3. Ambulatory cast brace method.
4. Fracture Brace technique.

SURGICAL MANAGEMENT

INTRODUCTION:

In the past 25 years, internal fixation of displaced fractures of lower end of femur has gained widespread acceptance as operative technique and implants have improved. The combination of properly designed implant, a better understanding of fracture pattern, meticulous soft tissue handling, judicious use of antibiotics, and improved anaesthetic methods have made internal fixation safe and practical. Since 1970, all studies comparing the results of conservative and operative methods have favoured operative stabilization of distal femur fractures.

The goals of operative treatment of distal femur fractures are

a) Anatomical Alignment

b) Stable Internal fixation

c) Early Mobilization

d) Early functional rehabilitation of knee.

Indications for operative management include

1) Displaced intraarticular fracture

2) Patients with Multiple injuries

3) Open fractures

4) Associated vascular injuries requiring repair.

5) Severe ipsilateral limb injuries (patellar fracture, tibial plateau fractures)

6) Major associated knee ligamentous injuries.

7) Irreducible fracture.

8) Pathological fracture

9) Fractures around TKR (Periprosthetic)

Contraindications to internal fixation include

1) Active infection

2) Severely contaminated open fracture (type III B)

3) Massive comminution (or) bone loss

4) Severe osteopenia

5) Inadequate facilities

6) Inexperienced surgeons

PROCEDURE

Sequences in the surgical management of supracondylar fracture includes

1) Restoration of articular surface

2) Metaphyseal alignment.

3) Impaction of fracture in osteoporotic patients.

4) Early mobilization of knee.

1) 95^0 CONDYLAR BLADE PLATE (CBP)

It is the first implant used for supracondylar fractures. When used by experienced surgeon, this restores alignment and provides stable internal fixation. Because it is a one piece device, it affords the best control of the fracture. However placing of 95^0 CBP is technically demanding procedure, leaving little room for error. It can be used for intercondylar fracture, provided the lateral cortex is not comminuted.

The main advantages of CBP is increased strength and increased corrosion resistance of implant. The disadvantage is the increased difficulty of insertion. In the distal femur, the blade has to be inserted so that it will line up with the axis of the shaft and with joint axis and with the inclination of patellofemoral joint and be inserted exactly in the middle of anterior half of the femoral condyle at a predetermined distance from the joint and has to line up with the axis of femoral shaft.

Initially the 130° plate was used for the distal femur also. With time it became evident that the 95° plate was the physiological one.

So CBP has a fixed angle of 95° between its blade and plate. Plate comes in varying diameter. The length to be used varies with fracture pattern. The shortest available blade is 50 mm.

2. DYNAMIC CONDYLAR SCREWS (DCS):

This is a less technically demanding alternative to the CBP. While the blade plate requires accurate insertion in three planes simultaneously, the DCS allows freedom in flexion & extension plane. A minimum of 4 cm of intact bone in the femoral condyle above the intercondylar notch is necessary for successful fixation. The main disadvantage is that the insertion requires removal of large amount of bone which makes revision surgery, should it be necessary, more difficult. Other advantages include its ability to apply interfragmentary compression across femoral condyles, better purchase in osteoporotic bone and the need for only two plane alignments. One technical disadvantage of this device is that its shoulder is more prominent than that of an angled blade; it causes knee symptoms such as the iliotibial sliding over the prominent edge of the implant producing severe irritation. In low supracondylar fractures, the condylar screw may not provide as much rotational control of the distal fragment as the 95° CBP.

3. CONDYLAR BUTTRESS PLATE:

Blade plates and condylar screws are unsuitable for use in fractures with <3-4cm of intact femoral condylar bone and in fracture with a large amount of articular comminution. For these fractures, the Condylar Buttress plate is the most commonly used implant. It is a one piece device specifically designed for the lateral surface of distal femur. It is essentially a broad DCP with a cloverleaf shaped distal portion designed to accommodate up to 6 cancellous screws. Because the posterior portion of cloverleaf is larger than anterior portion. It is manufactured separately for right and left sides. Mechanically it is not as strong as a blade plate or condylar screw with side plate and therefore should not be used or substituted for these preferred implant,. The problem with condylar buttress plate is that the screws passing through the distal holes do not have a fixed relationship to the plate., With indirect reduction techniques (such as the use of distraction device) the screws may shift relative to the plate producing varus deformity or valgus deformity., So its use should be restricted to cases in which the lateral femoral condyle is comminuted or there are multiple intra articular fractures in coronal plane or sagittal plane. In cases with extensive medial comminution a second medial plate need to be used to prevent varus deformities.

4. ANTEGRADE INTRAMEDULLARY NAILS:

Intramedullary nailing has received increased attention for the treatment of distal femoral fractures. These devices obtain more biological fixation than plates because they are load sharing rather than load bearing implants. They offer greater soft tissue preservation. Perhaps the most common application for an antegrade nail is a fracture in distal third of shaft of femur with fracture extension into the supracondylar region of knee joint, where it can also be used along with a small plate. The major disadvantage of nail fixation is that, it provides less rigid stabilization of distal femur fractures than plate fixation in biomechanical testing.

5. SUPRA CONDYLAR NAILS:

Nails have been designed specifically for retrograde insertion through intercondylar notch. It was developed by Green, Seligson and Henry and hence called GSH nail. It is a cannulated closed section stainless steel intramedullary device designed specifically to provide fixation for supracondylar fracture. It has an 8° apex anterior bend near the distal end to accommodate, the geometry of femoral condyles and transverse holes along its entire length to allow interlocking with 5 mm diameter interlocking screws. It is available in various lengths and diameter the most unique feature of the GSH nail is its intraarticular starting point, which allows it to be used for very distal fractures. Closed placement with indirect reduction of the fracture minimizes soft tissue and periosteal damage, thus preserving vascularity of the fracture site. Less surgical dissection is required resulting in less blood loss, less muscle damage and less postoperative discomfort. Distal femoral fracture below hip implant or above total knee implants with an open notch design may be effectively treated with retrograde nails. It can also be used in cases of floating knee, for simultaneously fixing femoral or tibial fractures. The design of the retrograde supracondylar nail is associated with potential disadvantages as well. The intraarticular portion will lead to knee stiffness, knee sepsis, patellofemoral degeneration, and synovial metallosis. The proximal tip of the nail generally lies in the mid or distal femoral shaft, creating a stress riser in this area.

6. FLEXIBLE AND SEMIRIGID NAILS:

In 1970 Zickel developed a nail specifically for use in distal femur; the nail has a flexible stem and a rigid curved condylar part, allowing it to be anchored by transfixation screws into femoral condyles.

Closed Rush pinning was also used for treatment of supracondylar fracture. But it was associated with complications like pin migration, knee irritation, loss of reduction & malunion.

7. Locking compression plate

It combines the advantages of the dynamic compression plate principle with the locking screw head principle, giving the surgeons great flexibility of choice within a single implant. The screw holes in plate have been specially designed to accept either a standard cortical screw with a hemi spherical head or a locking screw with a threaded head. A locked screw plate construct can be compared to an implanted external fixation device. When under load, the screws in the LISS and LCP plates and in the blade on the ABP distribute loading on cortical and cancellous bone. They form an angle stable construct. The plate is manufactured with a beveled edge, right and left separately because of larger posterior portion. The plate is precontoured to the lateral surface of distal femur. It allows up to 3 screws in the condylar potion. It comes in various lengths 5, 7 & 9 holed.

Anatomically precontoured: Reduces soft tissue problems and eliminates the need for plate contouring.

LCP combi-holes: Intraoperative choice between angular stability and compression.

Guiding Jig: Enable easy and correct mounting of the plate and enable screw fixation through guide and centering sleeves.

There is no consensus on the best treatment of complex intraarticular fractures and high energy diaphyseal fractures of the long bones. The Locking Compression Plate (LCP) and the Less Invasive skeletal Stabilization System (LISS) are the new implants with angular stability developed by the AO. The new screw-plate systems seem to offer an excellent alternative for the operative fixation in these cases.

POSTOPERATIVE MANAGEMENT:

Postoperative rehabilitation depends upon the fracture pattern and must be individualized for each patient. Antibiotic therapy is given according to the nature of injury.

In stable internal fixation the patients were started on knee mobilization & CPM exercise from 24-48 hrs after surgery once the patient tolerates pain, Isometric muscle strengthening exercises & limited active assisted knee range of motion is encouraged. Initially touch – down weight bearing is allowed and is progressed as callus formation increases over next 4-6 weeks. Full weight bearing is allowed only by 12 weeks.

COMPLICATIONS

The surgical treatment for supracondylar femoral fractures now has a better outcome than in the past because of improved implants. However the new methods are not without problems.

Complication of fractures:

1. Infection
2. Vascular injuries
3. Nerve injuries
4. Nonunion
5. Malunion
6. Pulmonary complications
7. Missed ligamentous injuries
8. Knee stiffness

Complication of operative treatment:

1. Incomplete reduction
2. Incongruous reduction
3. Loss of knee motion
4. Infection

INFECTION:

The major draw back of operative fixation of supracondylar femoral fracture is the risk of infection. However it should not exceed 5%. If wound drainage develops postoperatively, aggressive irrigation and debridement are indicated. Appropriate antibiotics should be given intravenously for 3 to 6 weeks. In the presence of infection, the implants should be retained because stable infected fractures are easy to manage than unstable infected fractures. However if the implant is loose, it should be removed and the fracture should be protected with external fixation.

NONUNION:

It is much more common in conservatively treated cases than in surgically treated cases, owing in part to the rich blood supply to the distal femur and the predominance of cancellous bone. Nonunion generally is due to presence of infection, unstable fixation, mechanical failure of the implant or any combination of these factors. Treatment may be difficult owing to preexisting osteopenia, proximity to knee joint and prior surgical procedures. Aseptic nonunion should be treated by repeat osteosynthesis. Septic nonunion should be treated with external stabilization.

POST TRAUMATIC ARTHRITIS:

The incidence of post traumatic arthritis is unknown. However incongruity of the joint surface is the leading cause of the early arthritis. Unfortunately lot of patients developing post traumatic arthritis is young patient becoming unsuitable for TKR. In patients where it is limited to one compartment, a corrective osteotomy may be indicated. In patients with severe disabling bicompartmental or Tricompartmental arthritis, knee arthrodesis (or) TKR may be necessary. Factors such as age, range of motion, presence or absence of flexion contractures and infections play a major role in surgical decision making.

KNEE STIFFNESS:

Perhaps the most common complication that occurs after supracondylar femur fracture is loss of knee motion. This untoward complication invariably results from damage to quadriceps mechanism and joint surface as a consequence of initial trauma (or) surgical exposure for fixation (or) both. Quadriceps scarring with (or) without arthrofibrosis of the knee (or) patellofemoral joint is thought to restrict knee movement. These effects are greatly magnified by immobilization after fracture, or internal fixation. Immobilization of the knee for a period of more than 3 weeks usually results in some degree of permanent stiffness.

Early stable internal fixation of the fracture with meticulous soft tissue handling and immediate mobilization of the knee maximize the chance for an optimal outcome after supracondylar fracture. Patients should have 90^0 of knee flexion 4 weeks postoperatively. Patients who failed to regain at least 90^0 of knee flexion between 8-10 weeks postoperatively usually warrant additional treatment. Arthroscopic lysis with manipulation can be done. Forcible manipulation should be avoided. Patients with significant loss of motion after an injury may be candidates for quadriceps plasty as a late reconstructive procedure.

VASCULAR INJURIES :

The exact incidence of vascular injury accompanying supracondylar fracture is unknown but is estimated to be only 2-3 %. Vascular injuries can be caused by direct laceration (or) contusion of the artery or vein by fracture fragments or indirectly by stretching leading to initial damage, clinical examination for signs of ischemia with evaluation of pulses and motor and sensory function is essential.

MALUNION:

Malunion of one or both condyles, as of the tibial condyles, distorts the articular surface of the knee, but it produces much more severe disability. It should be corrected and internally fixed with maintaining the articular surface.

PULMONARY COMPLICATIONS

When stabilization of the fractures was delayed in patients who had multiple injuries, the incidence of pulmonary complications was higher, patients who were treated conservatively or with late stabilization of fractures in polytrauma had high incidence of fat embolism (22%).

ASSOCIATED LIGAMENTOUS INJURIES

Concomitant ligamentous injuries to the knee are uncommon and are rarely diagnosed preoperatively. The most commonly injured Ligament is Anterior Cruciate ligament. Initially non operative treatment is advocated as repair (or) reconstruction may produce further comminution, prolonged operation time and increases the risk of loss of knee motion and infection. Protected motion in conjunction with a knee orthosis and vigorous rehabilitation may obviate the need for late reconstructive surgery. If necessary late reconstruction should be done after the fracture has healed.

EVALUATION OF OUTCOME

There are a lot of scoring system for evaluation of outcome. We followed the rating system of Neer. Other systems like the hospital total knee care system and Schatzker system are more complicated to follow:

NEER'S RATING SYSTEM:

CHARACTER	SCORE	DEFINITION
Pain	4 3 2 1	No pain in all ranges of motion Pain with normal daily activity Minimal activity gives pain Pain at rest
Movements (In degrees)	4 3 2 1	Flexion > 120 ; No FFD Full Extension, flexion 90 to 120 Loss of Extension less than 10 ; Flexion 70^0 to 90^0 Flexion < 60
Function	4 3 2 1	Full weight bearing, Normal gait, No functional impairment Limp, No restriction of activity Requires walking aid Cannot walk
Shortening (cm)	4 3 2	0 – 0.5 cm 0.5 to 2.5 cm 2.5 to 5 cm

	1	> 5 cm
Angulation (degree)	4 3 2 1	None < 10^0 $10\text{-}15^0$ > 15^0

Result	Score
Excellent	16 – 20
Good	12 – 16
Fair	8 – 12
Failure	4 - 8

Rating	Motion	Angulation	Pain	Shortening	Functional ability
Excellent	Full extension Flexion 90-120^0	None	None	None	Full weight bearing
Good	Full Extension	<10^0	Pain with normal	<2.5 cm	Limping ; no Restriction
Fair	Loss of extension < 10^0 Flexion 70 -90	$10\text{-}15^0$	Pain even with Minimal activity	2.5 – 5 cm	Requires walking Aid
Failure	Flexion <60^0	>15^0	Pain at rest	> 5 cm	Cannot walk

PREAMBLE

Supracondylar – Intercondylar fractures may be considered as an enigma in orthopaedics. Complex anatomical features, nature of injury, associated complications, technical difficulties in using the implants, cost factor, availability of implants and patient's general condition all have a bearing on the surgical management of these fractures.

This series includes 20 cases of distal femur fractures, all of whom were adults and all underwent internal fixation with Less Invasive Skeletal Stabilization using Locking compression plate osteosynthesis. The outcome was analyzed with special emphasis on range of knee movement.

Based on our findings we hereby submit "**A STUDY OF 20 CASES OF FRACTURES OF THE DISTAL FEMUR MANAGED WITH LESS INVASIVE SKELETAL STABILIZATION SYSTEM [LISS] USING LOCKING COMPRESSION PLATE [LCP]**"

AIM OF STUDY

- To discuss the role of less invasive skeletal stabilization system using locking compression plate in the management of fractures of distal femur.
- To discuss the biomechanical advantages of LCP.
- To discuss the biological advantages of LISS.
- To evaluate the results of the cases managed by LISS USING LCP.
- To study the post operative management & the functional outcome after Less Invasive Skeletal Stabilization with Locking Compression Plate for fractures of distal femur.

REVIEW OF LITERATURE

1. NEW SCREW-PLATE FIXATION SYSTEMS WITH ANGULAR STABILITY (LISS, LCP) FOR COMPLEX FRACTURES. PROSPECTIVE STUDY OF 23 FRACTURES WITH A FOLLOW UP OF 20 MONTHS.

Hernanz-GonzalezY. ; Diaz-MartinA. ; Jara SanchezF. ; and Resines ErasunC.

There is no consensus on the best treatment of complex intraarticular fractures and high energy diaphyseal fractures of the long bones. The Locking Compression Plate (LCP) and the Less Invasive Stabilization System (LISS) are the new implants with angular stability developed by the AO/ASIF. The new screw-plate systems seem to offer an excellent alternative for the operative fixation in these cases.

The outcome correlated with the severity of the fracture, anatomic reduction, exact positioning of the plate and concomitant injuries. Despite the large number of open and comminuted fractures no serious complications as deep infections, vascular lesions, DVT or non-unions were presented.

They found that the new internal fixator system to be a safe and reliable procedure. The new system offers numerous fixation possibilities and has proven its worth in complex fracture situations and in revision operation. A good knowledge of biomechanics is essential as well as precise preoperative planning.

2 J Orthop Trauma. 2004 Sep;18(8):509-20.

Treatment of distal femur fractures using the less invasive stabilization system: surgical experience and early clinical results in 103 fracture Kregor PJ, Stannard JA, Zlowodzki M, Cole PA.

Treatment of distal femur fractures with the LISS is associated with high union rates without autogenous bone grafting (93%), a low incidence of infection (3%), and maintenance of distal femoral fixation (100%). No loss of fixation in the distal femoral condyles was observed despite the treatment of 30 patients older than 65 years. The LISS is an acceptable surgical option for treatment of distal femoral fractures.

3. J Orthop Trauma. 2001 Sep-Oct;15(7):482-7.

Biomechanical evaluation of the less invasive stabilization system for the internal fixation of distal femur fractures.

Marti A, **Fankhauser C**, **Frenk A**, **Cordey J**, **Gasser B**.

Dr. H. C. Robert Mathys Stiftung, Bettlach, Switzerland.

The results suggest an enhanced ability to withstand high loads when using the monocortical screw fixation technique with angular stability. A higher elastic deformation of LISS compared with conventional plating systems in distal femoral fractures can be explained by the lower bending stiffness caused by different design and material properties.

4. J Orthop Trauma. 1996;10(6):372-7.

The results of open reduction and Internal fixation of distal femur fractures using a biologic (indirect) reduction technique.

Bolhofner BR, **Carmen B**, **Clifford P**.

Holding the surgical skill factor constant, it appeared that biologic reduction techniques, although they provided excellent bone healing capability, did not guarantee universally satisfactory outcomes.

5. J Orthop Trauma. 2004 Sep;18(8):494-502. Links

Biomechanical evaluation of the less invasive stabilization system, angled blade plate, and retrograde intramedullary nail for the internal fixation of distal femur fractures.

Zlowodzki M, Williamson S, Cole PA, Zardiackas LD, Kregor PJ.

Evaluated the stability of the retrograde intramedullary nail (IMN), angled blade plate (ABP), and a locked internal fixator Less Invasive Stabilization System [LISS], for internal fixation of distal femur fractures.

All 3 fixation devices (LISS, ABP, and IMN) offer sufficient torsional stability and sufficient proximal fixation that withstands axial loading without failing. The LISS provides improved distal fixation, especially in osteoporotic bone, at the expense of more displacement at the fracture site.

MATERIALS AND METHODS

This is a prospective study of 20 cases of fractures of distal femur in adults treated by Less Invasive Skeletal Stabilization System (LISS) using Locking Compression Plate (LCP).

The period of surgery and follow up extends from November 2005 to November 2007

It includes all grades of supracondylar and intercondylar fractures. Pathological fractures and fractures in children were excluded.

The case were analysed as per the following criteria.

1. Age distribution
2. Sex distribution
3. Side of injury
4. Mode of injury
5. Anatomy of injury
6. Grading of injury
7. Subtype of fracture
8. Associated injuries
9. Open fractures

1. AGE DISTRIBUTION

The age groups varied from 19 years to 70 years with the mean age of 48 years. Incidence of fracture was observed maximum between 40 – 60 years of age.

Age Group	Number of cases	Percentage
12 – 20 years	1	05%
20 – 30 years	2	10%
30 – 40 years	2	10%
40 – 50 years	7	35%
50 – 60 years	5	25%
60 – 70 years	3	15%

2. SEX

Among the 20 cases, males were predominant with female to male ratio being 1:4

Sex	Number of cases	Percentage
Male	16	80 %
Female	4	20 %

3. SIDE OF INJURY:

Right side was common in our series

Sex	Right	Left	Total
Male Female	13 3	3 1	16 4
Percentage	80%	20%	100%

4. MODE OF INJURY :

Commonest mode of injury has been road traffic accident

Mode of Injury	Number of cases	Percentage
RTA Fall	16 4	80 % 20%

5. ANATOMY

6. GRADE

7. SUBTYPE OF FRACTURE

Out of 20 cases fractures of distal femur with intercondylar extension accounted for more number of cases followed by isolated supracondylar fractures.

Muller’s subtype	Number of cases	Percentage
A1	2	10%
A2	2	10%
A3	4	20%
B1	-	-
B2	-	-
B3	-	-
C1	3	15%
C2	3	15%
C3	6	30%

8. **ASSOCIATED INJURIES**

Head injury - 2

Fracture Both bone leg - 3

Acetabular fracture - 1

Galeazzi fracture dislocation - 1

9. OPEN FRACTURES

There were two open fractures, one was compound grade III A and other was compound grade II fracture.

PROCEDURE:

General Measures

All the patients were received in the casuality department and were resuscitated. After the general condition improved X rays AP and lateral views were taken. A detailed preoperative work up was done. All the cases were taken for surgical procedure as soon as possible. Those cases which were compound were initially treated with external fixator.

SURGICAL PROCEDURE:

Less Invasive Skeletal Stabilization system [LISS] using Locking Compression Plate [LCP]:

Under spinal Anaesthesia patient positioned supine on the radiolucent table allowing both AP and lateral views. The uninjured limb should be extended. The injured limb is draped so as allow 30^0-60^0 of flexion to relax Gastrocnemius muscle.

In complex fractures preparation of both the limb was done to achieve correct adjustment and comparison of length and rotation.

A lateral approach is used. A 5-7cm long skin incision is made, Sub Cutaneous tissue, vastus lateralis, tensor fascia lata incised till the lateral condyle is reached, submuscular tunnel is created along the shaft of femur.

Indirect reduction of the condyles done using point reduction clamp and image intensifier. Reduction held temporarily using two K wires by avoiding disturbance to plate positioning. The plate along with jig assembly is slid along the shaft submuscularly using the bevel. The jig plate assembly is held with distal condylar portion with a temporary K wire.

The condylar fragment was aligned with metaphyseal fragment by appropriate manipulation (traction and rotation) under image control. The reduction was held temporarily with k wire, after aligning the plate along the shaft.

After confirming the reduction and plate position parallel to the condyles the second K wire passed into the jig, plate and condyle. In this position the anatomically prebent implant matches the distal femur.

The condyles were fixed to the plate using 6.5mm cannulated locking head cancellous screws without disturbing the reduction. The reduction and the position of the plate were controlled clinically and by image intensifier help (axis, length, and rotation). The locking head screws inserted using stab incision using jig sleeve assembly with image intensifier in accordance with pre op planning. For biomechanical reasons some holes were left unoccupied.

The insertion guide is removed and wound is closed over a suction drain. Sterile non bulky dressing applied.

ADVANTAGES

Closed reduction of the intraarticular fracture component without exposing the knee joint, combined with an indirect reduction technique for the complex metaphyseal component.

Careful control of implant position using direct and indirect control mechanisms (visualization, palpation, and image intensification).

The use of long implants and few screws is necessary to allow implant elasticity and better stress distribution (splinting method is an elastic fracture fixation).

POST OPERATIVE PROTOCOL

Second postop day	:	ROM exercises started along with quadriceps and hamstrings exercises.
In the I week	:	ROM with CPM
By eighth post op day	:	touch down weight bearing started
By four to six weeks	:	Partial weight bearing started
By 14 to 16 weeks	:	full weight bearing started

Radiological examination:

Immediate post op

At the end of 4 weeks

At the end of Six weeks

At the end of 8 weeks

At the end of 12 weeks

At the end of 4 months

Every Six monthly upto two years.

FOLLOW UP:

All the patients were followed up carefully looking for any complication every fortnightly till fracture healing. And there after every monthly upto 6 months. And every 6 monthly upto two years.

RESULTS

Average healing of the fractures was 12.1 weeks. In compound fractures it was delayed to an average of about 14.5 weeks.

The malalignment was less than 7 degrees (varus, valgus). All the patients had good articular alignment. None had a step > 2mm or more the average knee flexion in our series was 90^{o} ranging from 15°-130^{0}, the knee flexion varied according to the subtype of the fracture.

Shortening less than 1 cm was recorded in 8 cases and shortening of 7 cm was recorded in one case. All the patients remained painless in the post operative period, except for 3 cases which had wound infection.

Functionally all the patients discarded walking aid by 16 weeks and one patient was using heel and sole rise.

ANALYSIS OF FUNCTIONAL OUTCOME

The NEER's rating system was used this system is easy to follow and easy to analyze. It takes into account pain, movement, function, shortening and angulation.

OVERALL RESULTS

GRADING	NO OF CASES	PERCENTAGE
EXCELLENT	12	60
GOOD	4	20
FAIR	3	15
FAILURE	1	05

RESULTS ACCORDING TO INDIVIDUAL CRITERIAS

CHARACTER	SCORE	NO OF PATIENTS
Pain	4	12
	3	2
	2	2
	1	4
Movements (In degrees)	4	4
	3	6
	2	7
	1	3
Function	4	10
	3	7
	2	2
	1	1
Shortening (cm)	4	11
	3	8
	2	0
	1	1
Angulation (degree)	4	19
	3	1
	2	0
	1	0

RESULTS ACCORDING TO SUBTYPE

MULLER'S SUB TYPE	SCORING			
	EXCELLENT	GOOD	FAIR	FAILURE
A1	2	-	-	-
A2	2	-	-	-
A3	3	1	-	-
C1	1	1	1	-
C2	1	1	1	-
C3	2	2	1	1

COMPLICATIONS AND THEIR MANAGEMENT

INFECTION:

3 cases developed wound infection, of them 2 were deep and occurred in compound fractures and 1 case was a superficial infection. The treatment protocol followed for superficial infection was continuation of appropriate antibiotics, for 3 weeks daily dressing with antiseptics, healed well without any complication.

The deep seated infection that occurred postoperatively were thoroughly irrigated, all slough were thoroughly excised and appropriate antibiotics continued. The healing time was delayed in these cases.

KNEE STIFFNESS

Knee stiffness occurred in 2 cases.

These patients underwent manipulation under anaesthesia and was advised active and assisted range of motion exercises for knee joint.

MALUNION

Malunion occurred in one case that patient was very old (66 years) and his functional disability was minimal and his range of motion of knee joint was good, he was left without any intervention.

DELAYED UNION

Delayed union occurred in 2 cases. It took 14 and 15 weeks for complete union in these cases. Nothing except active physiotherapy was advised in these cases.

LIMB LENGTH DISCREPANCY

Shortening of less than 1 cm was observed in 8 cases they did functionally well without any intervention. Shortening of 7 cm occurred in 1 case which was a compound injury with bone loss managed initially by knee spanning external fixator and later by Less Invasive Skeletal Stabilization System using Locking Compression Plate and bone grafting. Limb Length Discrepancy was managed appropriately.

DISCUSSION

The aim of this study is to discuss the results of fractures of distal femur managed by less invasive skeletal stabilization system [LISS] using Locking Compression Condylar Plate [LCP] and to analyse the results.

Stable fixations were done for all the subtypes of the fracture and were followed up with proper physiotherapy and rehabilitation which are more important than the surgery. Very minimal soft tissue was damaged during the procedure. The operative time was reduced but initially the procedure did take more time than formal fixation procedures.

As we did a very minimal soft tissue dissection and proper physiotherapy with CPM, we had good range of knee movement and hence a good knee function was obtained.

We did LISS using LCP for 20 cases of which type A1, A2, 2 each A3, 4 cases and 12 cases with intra articular extension. 5 of them were osteoporotic. 2 were compound fractures. The period of study was between November 2005 to November 2007. Most of the cases fell into 5^{th} & 6^{th} decade most were due to high velocity injury and all cases were individualized. According to the fracture subtype, meticulous pre operative planning for screw placement and plate positioning was done.

In compound fractures, after thorough wound wash and thorough debridement, closed primarily, LISS using LCP was used for fracture fixation, but two cases developed deep wound infection inspite of antibiotic prophylaxis.

In the initial cases the size of incision was larger (7cm) and the incised vastus lateralis was carefully sutured with 2 O vicryl with knots buried in the substance and the capsule was meticulously closed. As advised by M.S. BUTT, RIRKLER and ALI series (meticulous closure of approaches mandatory for earlier postoperative rehabilitation).

We avoided using of tourniquet as advocated by MICHEL, CHAPMAN & CHRISTOPHER, FINKEMCIER because the plate is slid proximally to a longer distance. We also avoided fracture table because it was found to be easier for moving the knee joint on ordinary table. The traction was given using upper tibial and calcaneal pin insitu.

In intraarticular fractures closed reduction of articular fragments using point reduction clamps under image control and indirect reduction for the complex metaphyseal component and careful implant positioning using jig and image intensifier was done.

The implant acts as an internal splint since we used long plates with few locking screws, allowing the implant elasticity and better stress distribution (splinting method is an elastic fracture fixation). An angle stable construct biomechanically, withstands high load as evidenced in the cadaver study by MATRI, FRANHAUSER, EVENT, CORDEY GASSER. Since sliding of the plate with the beveled edge makes a minimal soft tissue damage the blood supply of the metaphyseal fragment is not compromised making the fixation biological. But the fracture hematoma could not be preserved to the extent of closed nailing. The plate is placed submuscularly well away from the bone so, there is no compression of plate to bone hence preserving the periosteal blood supply and also the plate profile is of low contact making it a more biological one.

Careful patient selection, meticulous preoperative planning and skillful execution peroperatively makes the LISS LCP an ideal method for severely comminuted fractures as concluded by HERNANZ, PIAZ, JAVA, and REGINES. Most series follow NEER's system, but other series like SHEWRING and MEGGITT followed other system like SCHATZKER's system.

We followed the rating system of NEER for functional evaluation which gives equal importance to practical (pain, disability) clinical (shortening, knee flexion) and radiological (angulation) marker. We had 60% excellent and 20%good, results with this system.

The results as per NEER rating system was excellent to fair, and good and fair results were due to poor knee motion due to non compliance of patients and the one failure case in our series was attributed to infection.

Our results varied according to fracture subtype. All cases united within expected time but for two cases both were compound had deep infection requiring repeated debridement and irrigation, ultimately ended in delayed union. 1 case had varus collapse. Mal union was seen in 1 case.

The mean range of knee motion was 15°-130°. The results were comparable to the study by KREGOR PJ STANDARD, JA, ZLOVODZKI, core PA publication of early results of LISS LCP in 103 fractures in 2005 September.

We focused on the importance of minimal soft tissue damage and earlier mobilization of knee using proper postoperative rehabilitation and found that the LISS is a good technique and LCP is an ideal implant for fractures of distal femur.

CONCLUSION

The conclusions of this study are

- Fractures of distal femur are more common in high velocity injuries and occur in middle aged men and old age women. Most fractures were comminuted.

- Less invasive skeletal stabilization system [LISS] using locking compression plate [LCP], (angle stable construct) with proper physiotherapy produced excellent results.

- Locking compression plate [LCP] appears to be technically an ideal implant for comminuted and osteoporotic bones.

Infection, knee stiffness and malalignment of fractures were the common complication we encountered in our series which could be tackled by surgical expertise, meticulous soft tissue handling, judicious use of antibiotics and vigorous early knee mobilization.

In conclusion less invasive skeletal stabilization system [LISS] using locking compression plate [LCP] produces better results and appears to be a good method of choice for management of fractures of distal femur.

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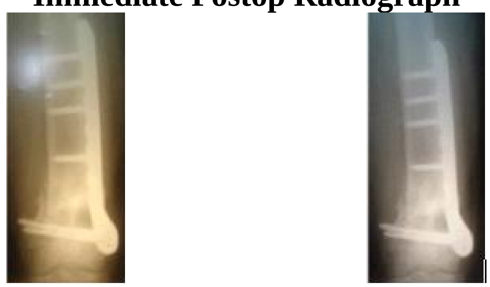
CASE – 1
45 Yrs / M: RTA, Muller's type C2
Preoperative x-ray

Immediate Postop Radiograph



3 months follow up

6 months follow up

LISS scar
Full Extension of knee

Good range of knee movement

Case – 2

32 yrs / M: RTA, Muller's type C1

Pre op

Immediate post op

3 months follow up

Good range of Knee movement

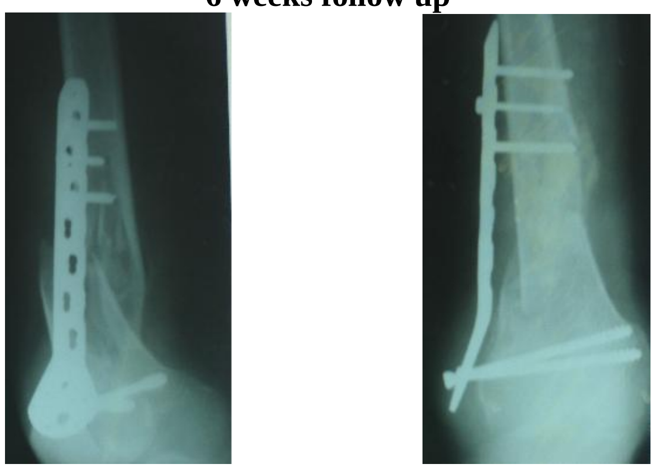
Case – 3

56 yrs / M: RTA, Muller's type A3

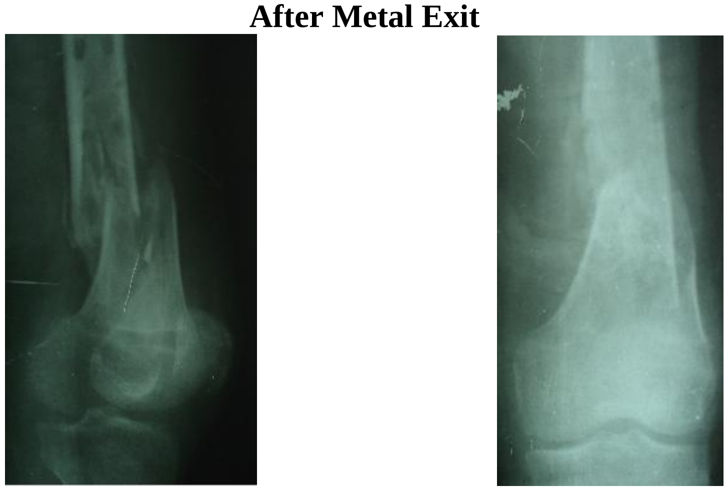
Immediate Post p

1 month follow

6 weeks follow up



After Metal Exit



Case – 4
66 yrs / M: RTA, Muller's type A3

Pre op x-ray

AP view

Lateral view

Immediate post op

2 months follow up

3 months follow up

With good bridging callus

Excellent range of knee movement

COMPLICATIONS

35 YRS/M: RTA, COMPOUND GRADE - II

WOUND INFECTION

AFTER DEBRIDEMENT

HEALING WOUND

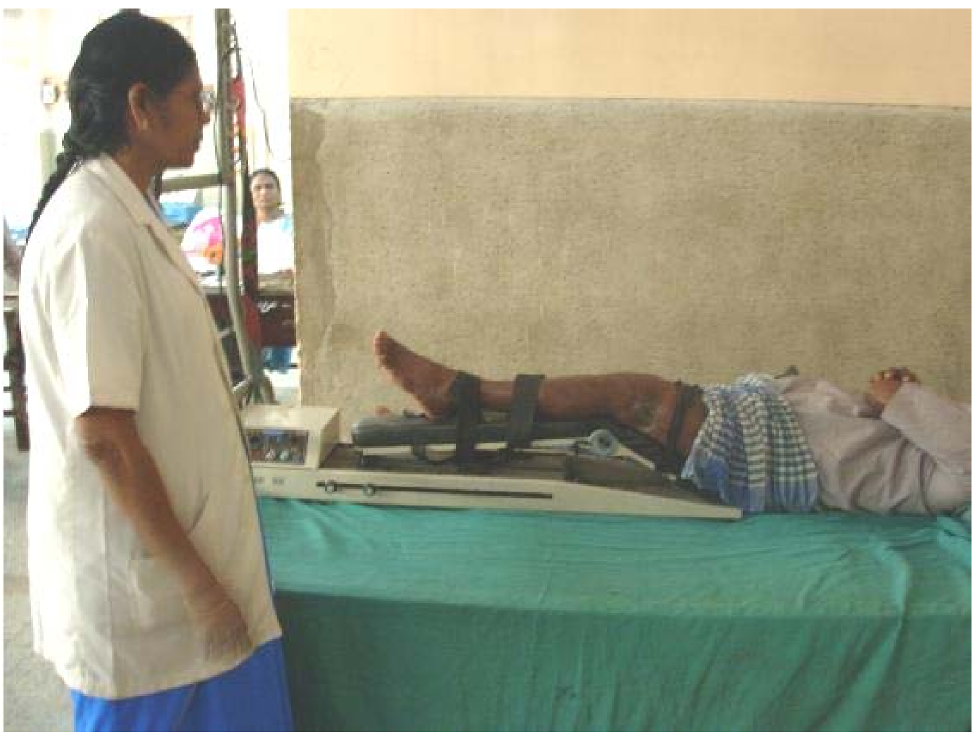
COMPLICATIONS

36 YRS/ M: RTA, COMPOUND FRACTURE
Shortening (7cm)

MANAGED WITH HEEL
AND SOLE RISE

PHYSIOTHERAPY

CPM



RANGE OF KNEE MOVEMENT (100°) IN CPM

IMPLANT

INSTRUMENTATION

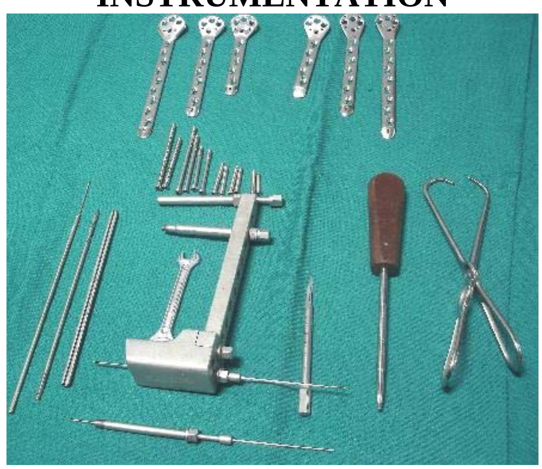
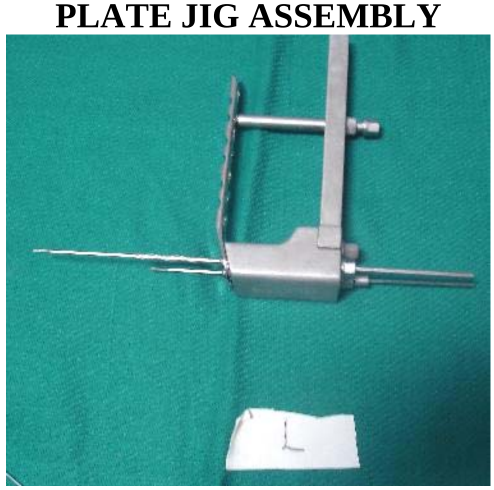


PLATE JIG ASSEMBLY

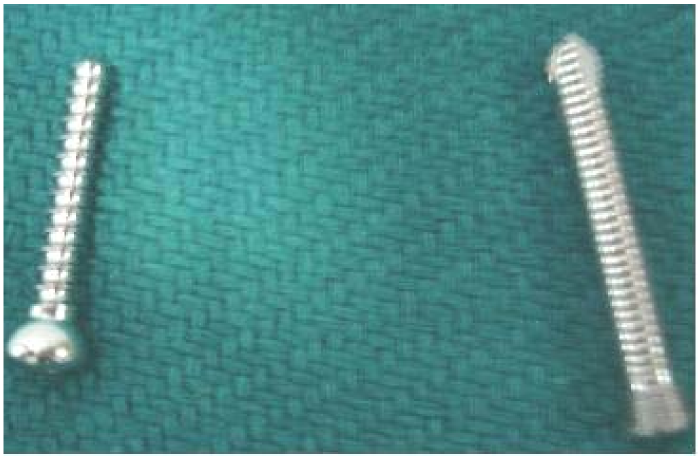


IMPLANT PROFILE

6.5 mm locking head screw

4.5mm cortical screw

5mm locking head screw



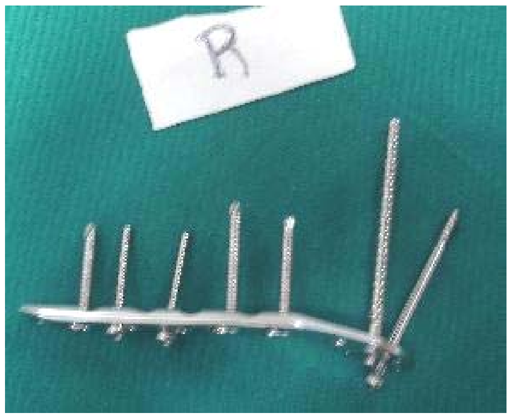
LOCKING PLATE WITH BEVELLED EDGE

COMBI – HOLED LOCKING PLATE

IMPLANT PROFILE

RIGHT AND LEFT PLATES

ANGULAR STABLE CONSTRUCT



EXTERNAL JIG

CASE – 5

36 YRS/ M COMPOUND SC

Preop

Post op

2 months follow up

4 months follow up

Knee Range of Movement

PROCEDURE

LATERAL APPRAOCH

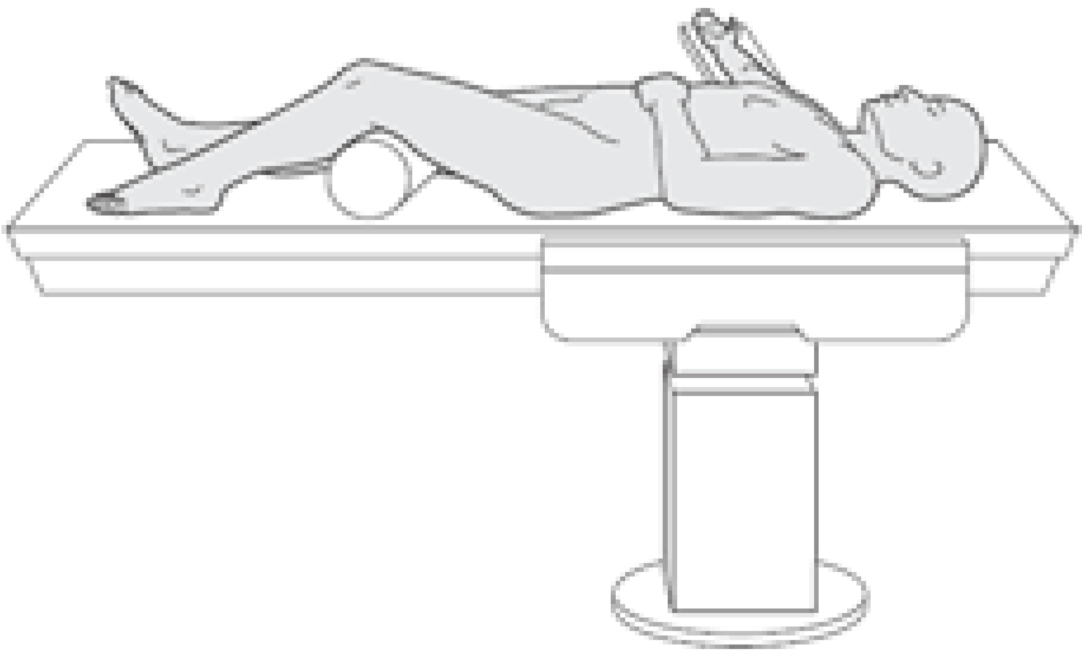
SUBMUSCULAR TUNNEL

PLATE POSITIONING USING JIG

SCREW FIXATION USING JIG

AFTER PLATE FIXATION

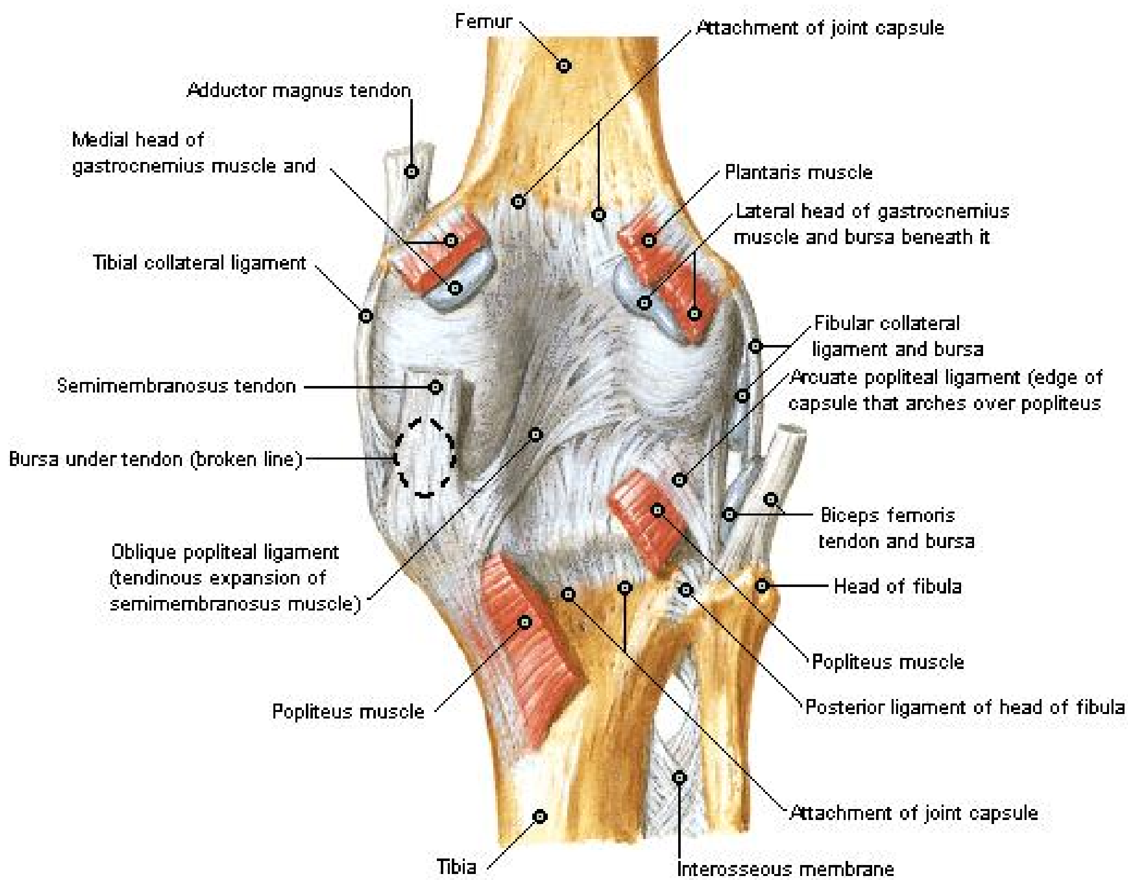
PATIENT POSITION



LATERAL APPROACH

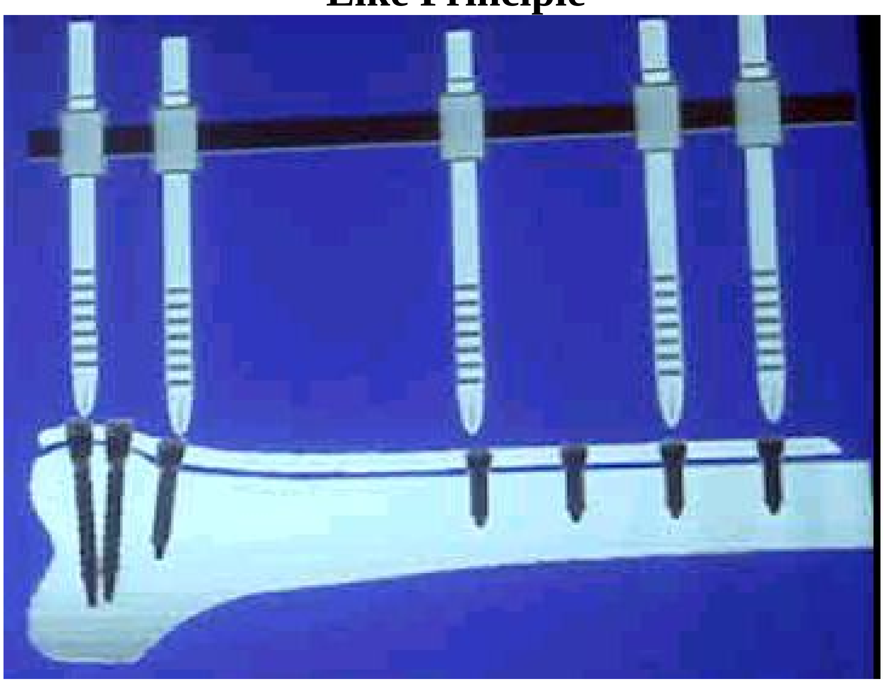
Knee

Posterior View

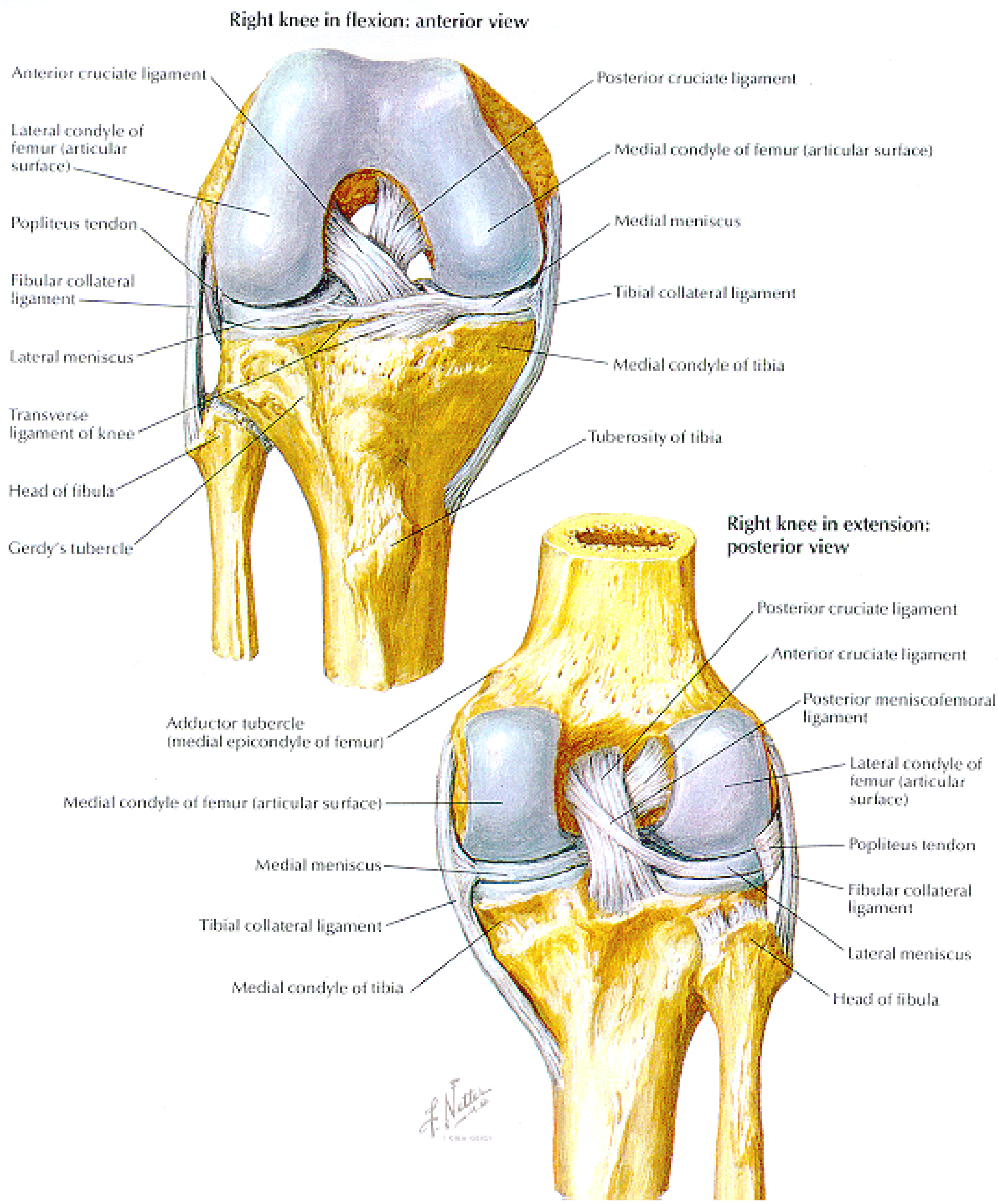


ANGLE STABLE CONSTRUCT

INTERNALLY PLACED EXTERNAL FIXATOR
- Like Principle

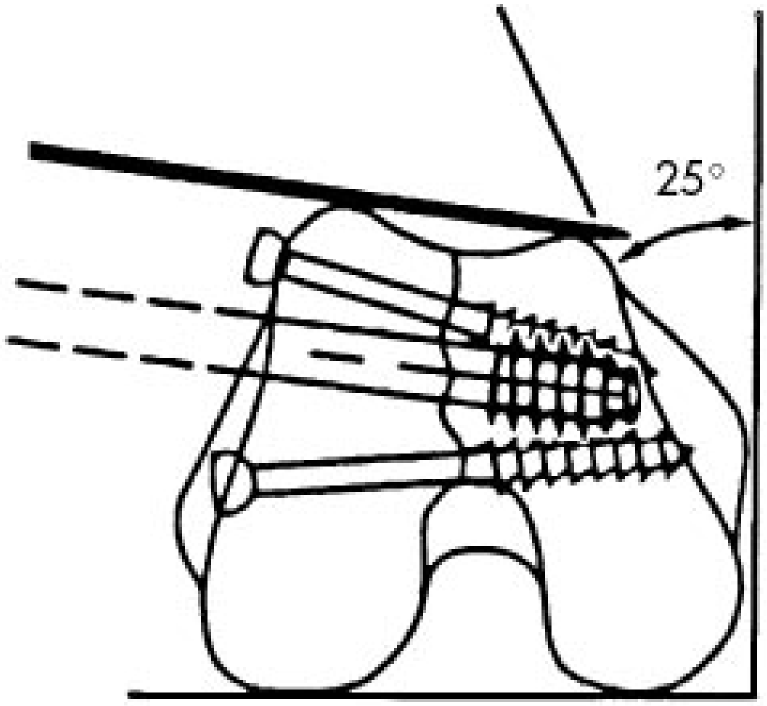


ANATOMY

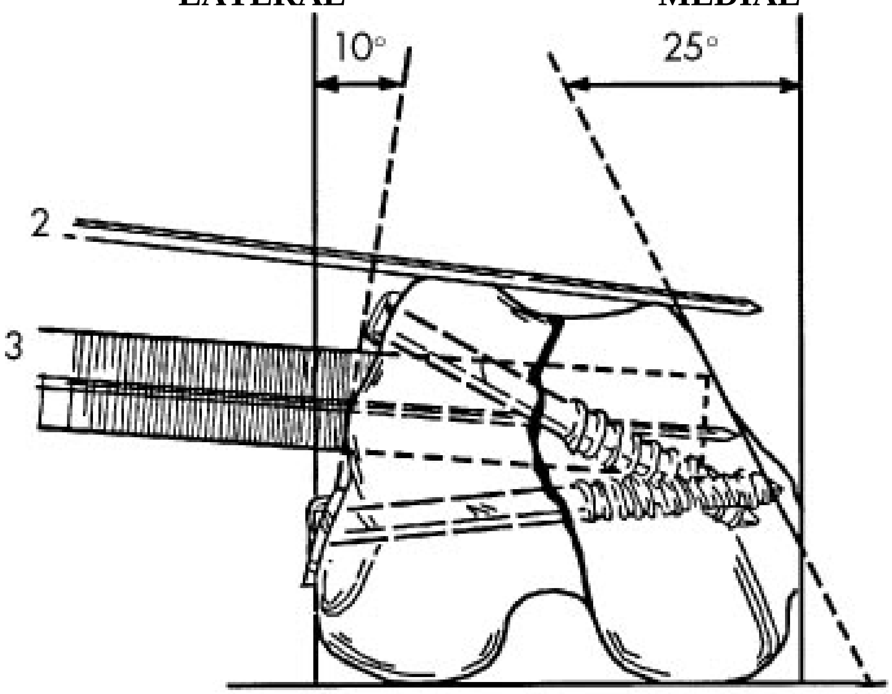


Right knee in flexion: anterior view
Anterior cruciate ligament
Lateral condyle of femur (articular surface)
Popliteus tendon
Fibular collateral ligament
Lateral meniscus
Transverse ligament of knee
Head of fibula
Gerdy's tubercle
Posterior cruciate ligament
Medial condyle of femur (articular surface)
Medial meniscus
Tibial collateral ligament
Medial condyle of tibia
Tuberosity of tibia
Right knee in extension: posterior view
Posterior cruciate ligament
Anterior cruciate ligament
Posterior meniscofemoral ligament
Lateral condyle of femur (articular surface)
Popliteus tendon
Fibular collateral ligament
Lateral meniscus
Head of fibula
Adductor tubercle (medial epicondyle of femur)
Medial condyle of femur (articular surface)
Medial meniscus
Tibial collateral ligament
Medial condyle of tibia

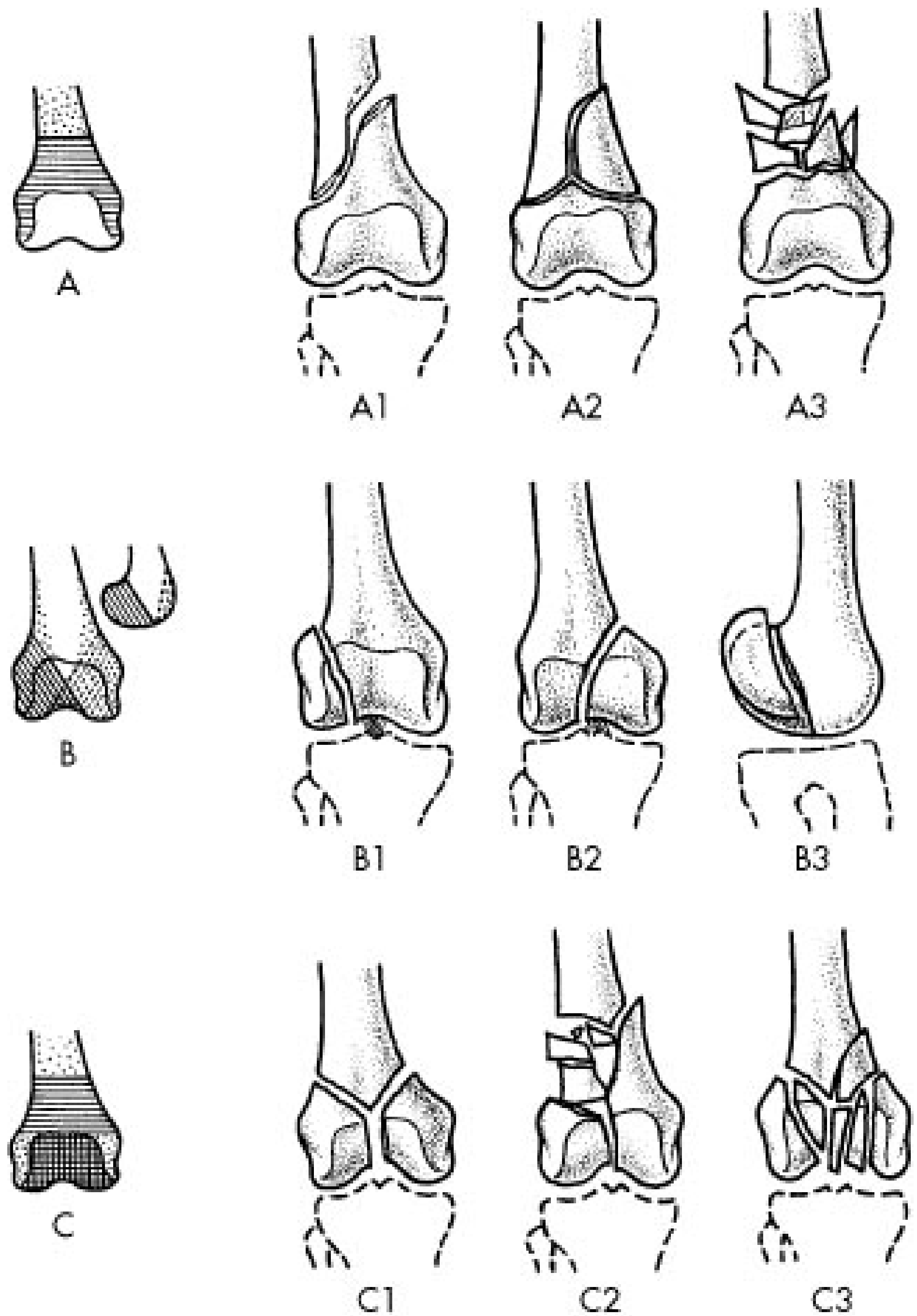
BIOMECHANICS



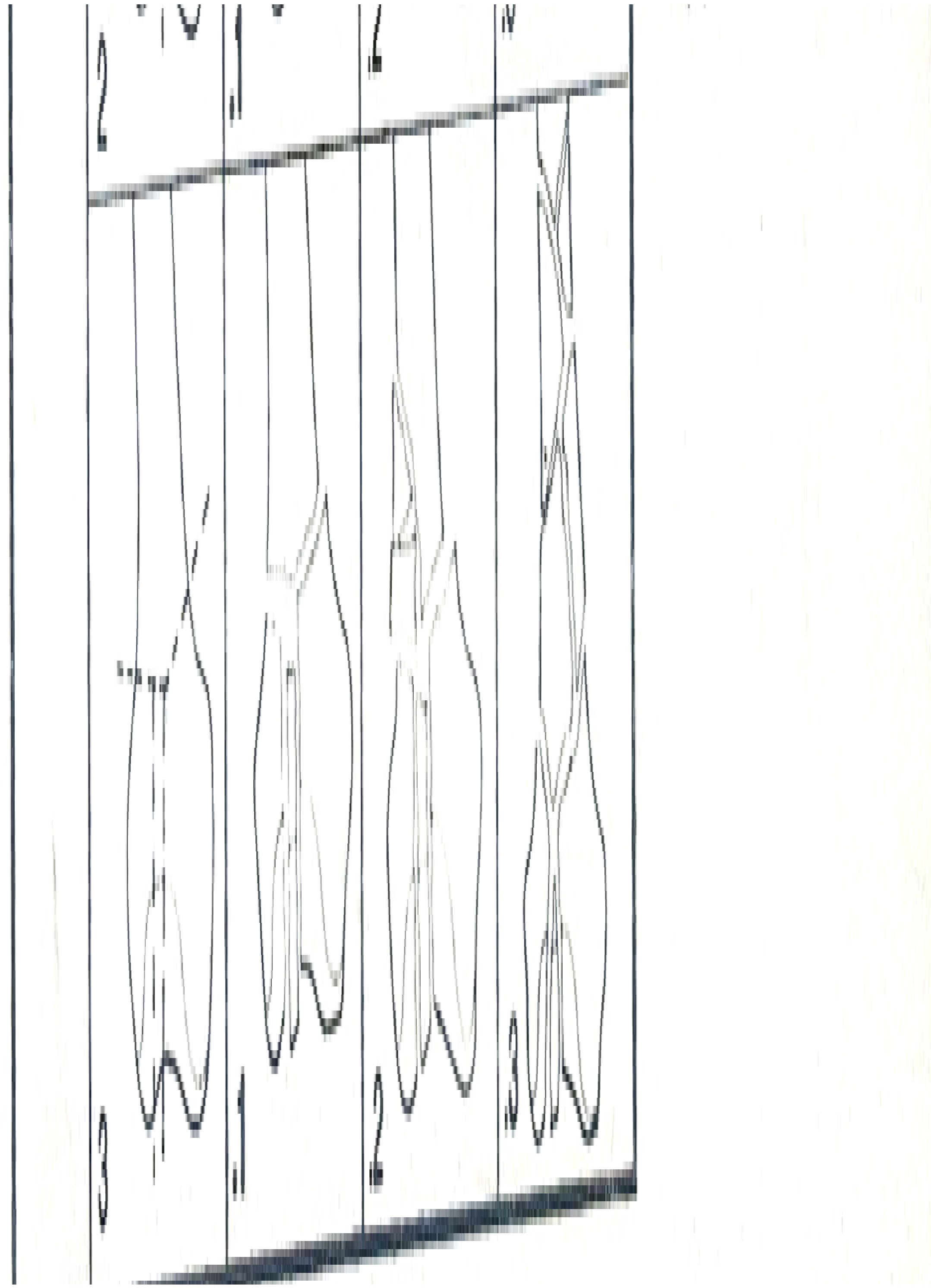
LATERAL MEDIAL

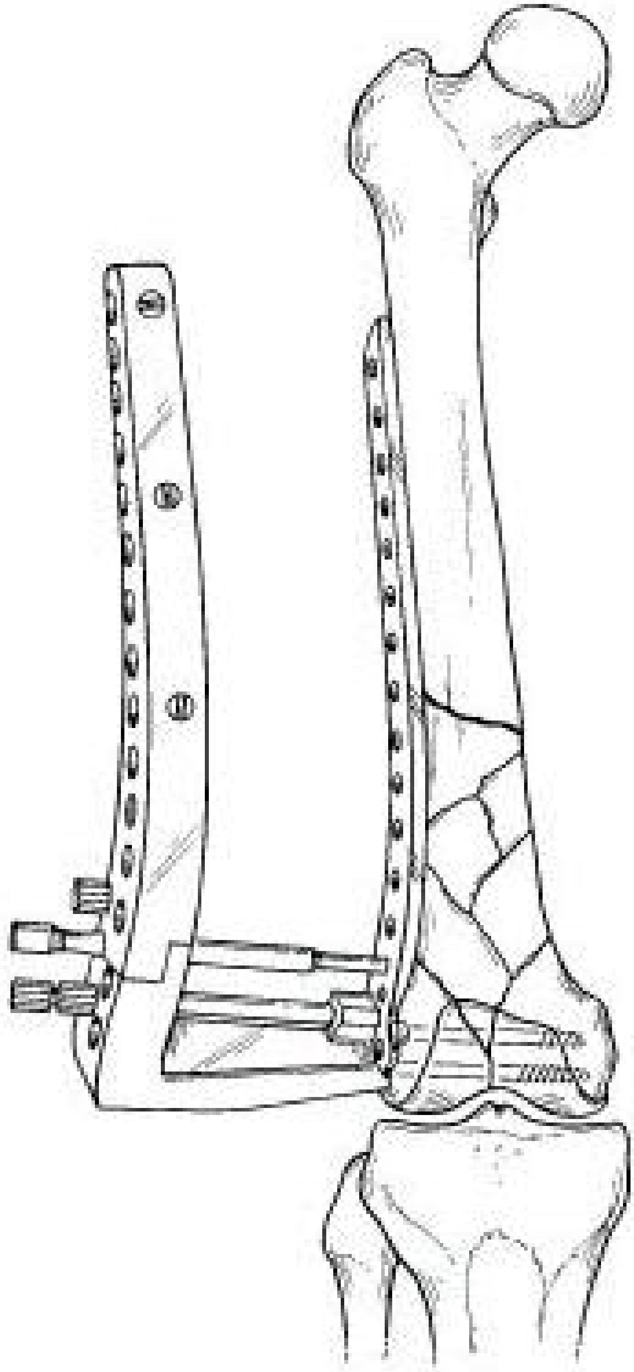


MULLER'S CLASSIFICATION

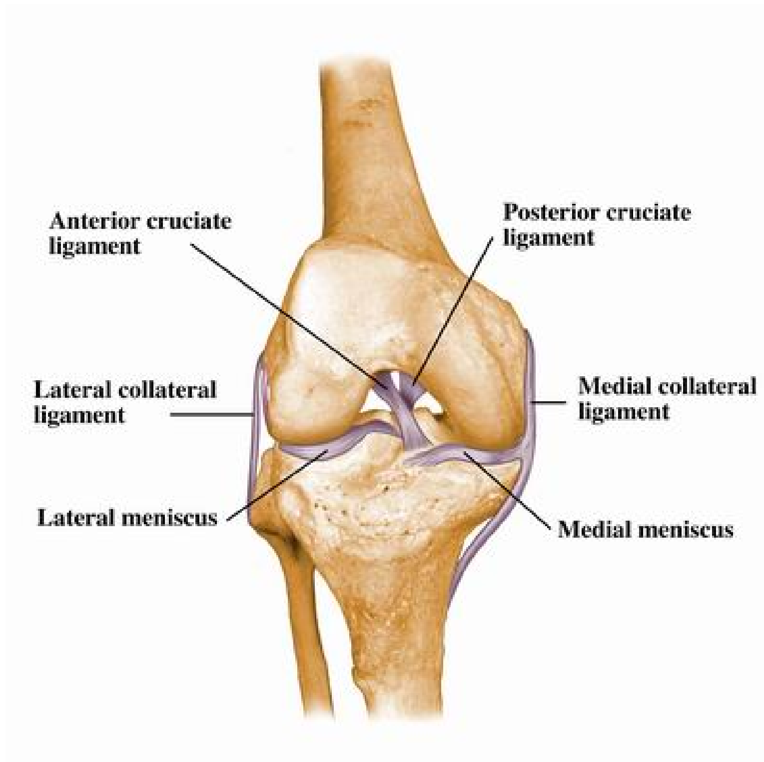


AO CLASSIFICATION

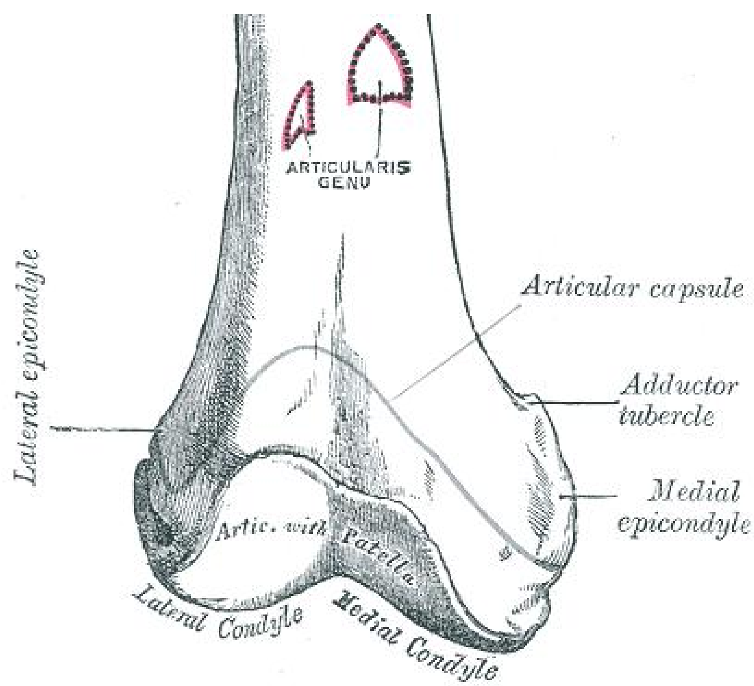




ANATOMY

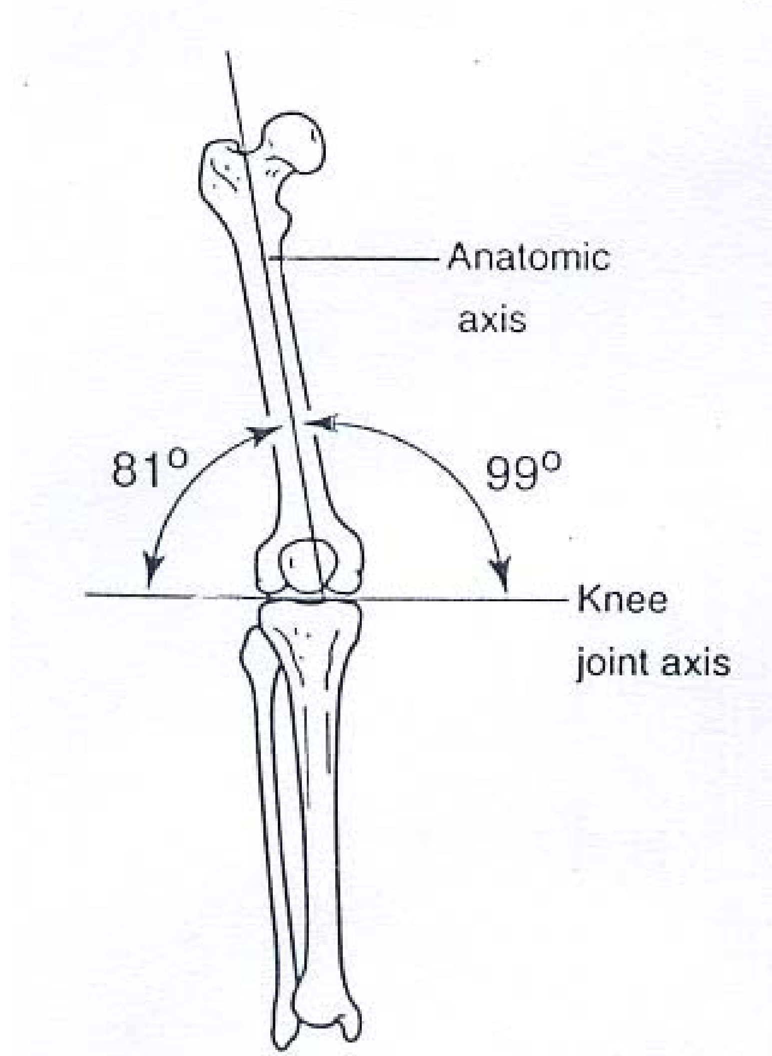


ANTERIOR ASPECT



BIOMECHANICS

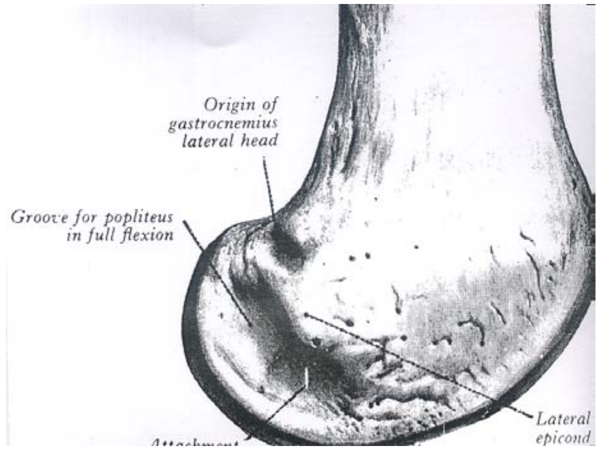
ALIGNMENT OF LOWER EXTREMITY



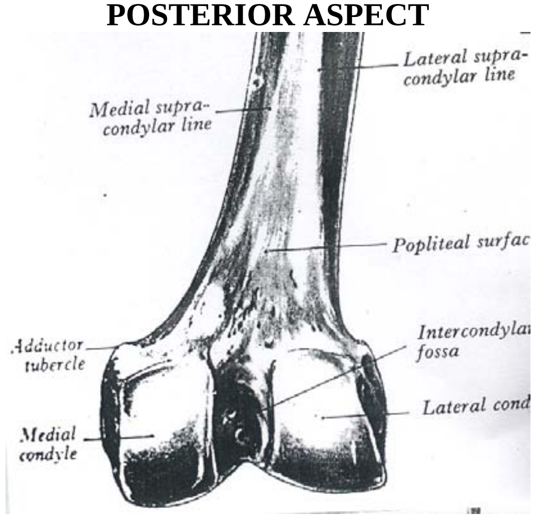
- **Knee joint axis is parallel to the ground.**
- **The anatomical axis is 9° valgus to the knee**

ANATOMY

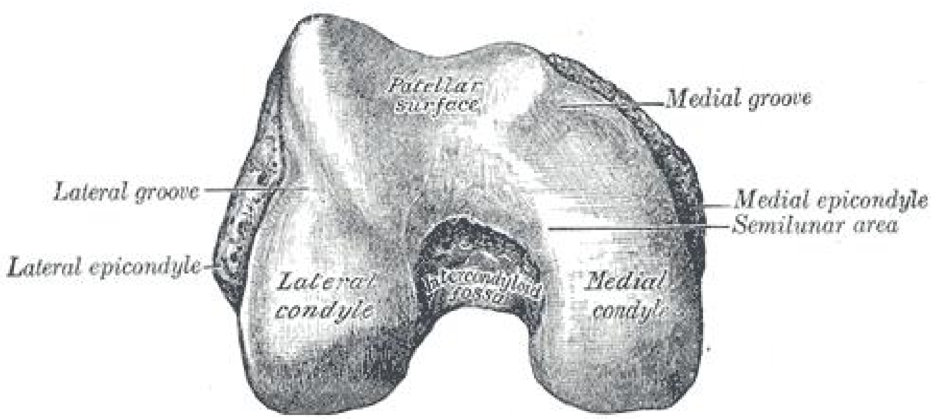
LATERAL ASPECT



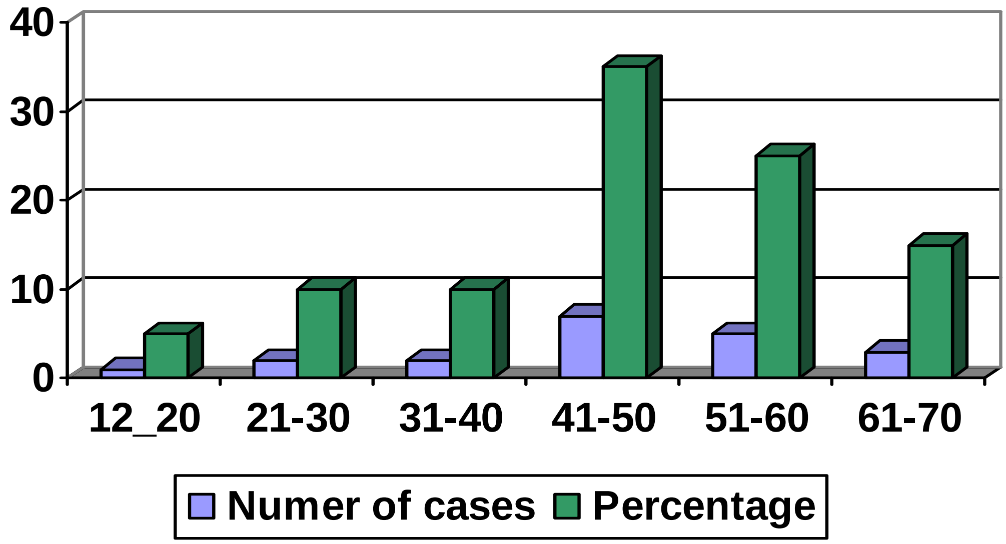
POSTERIOR ASPECT



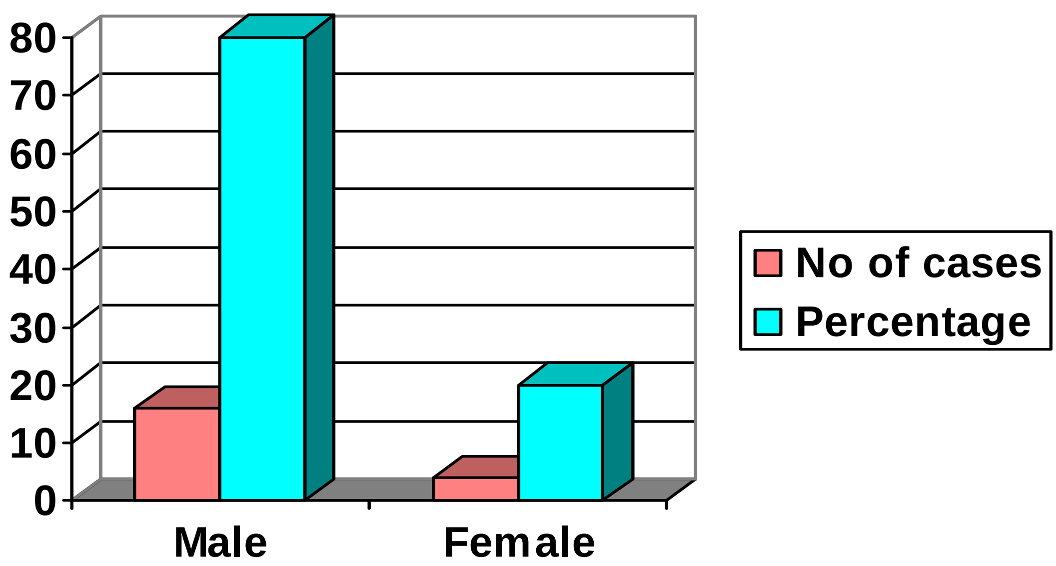
INFERIOR ASPECT



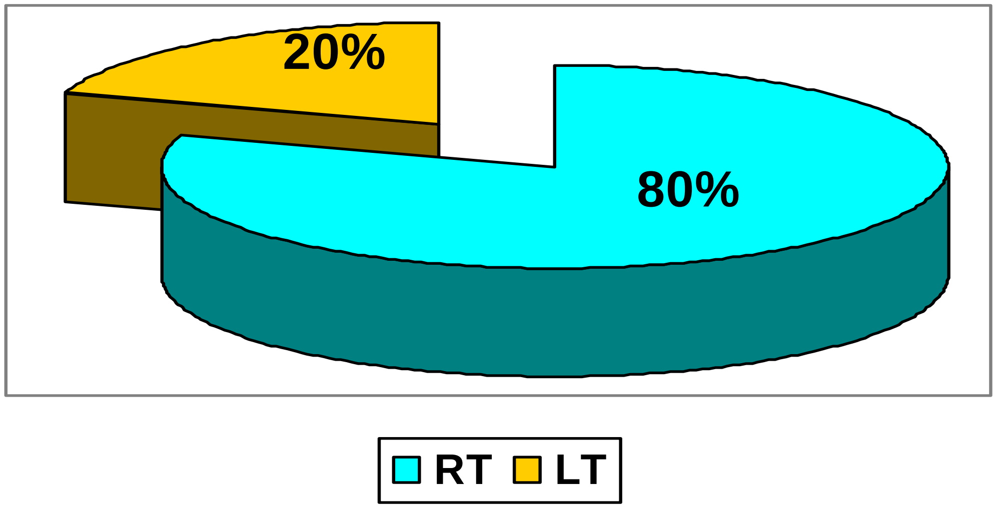
AGE DISTRIBUTION



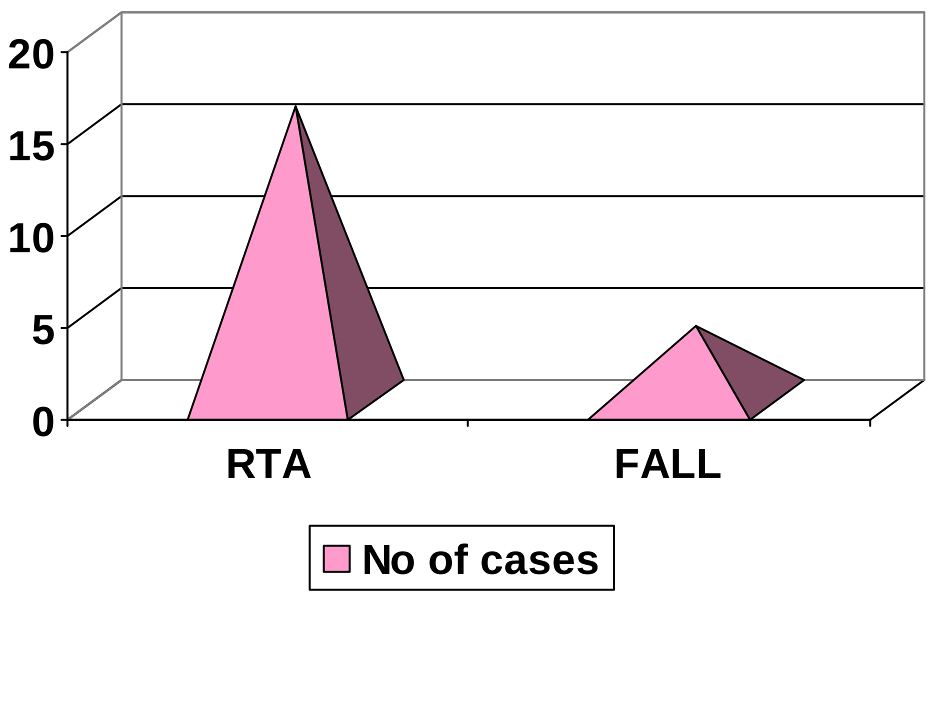
SEX DISTRIBUTION

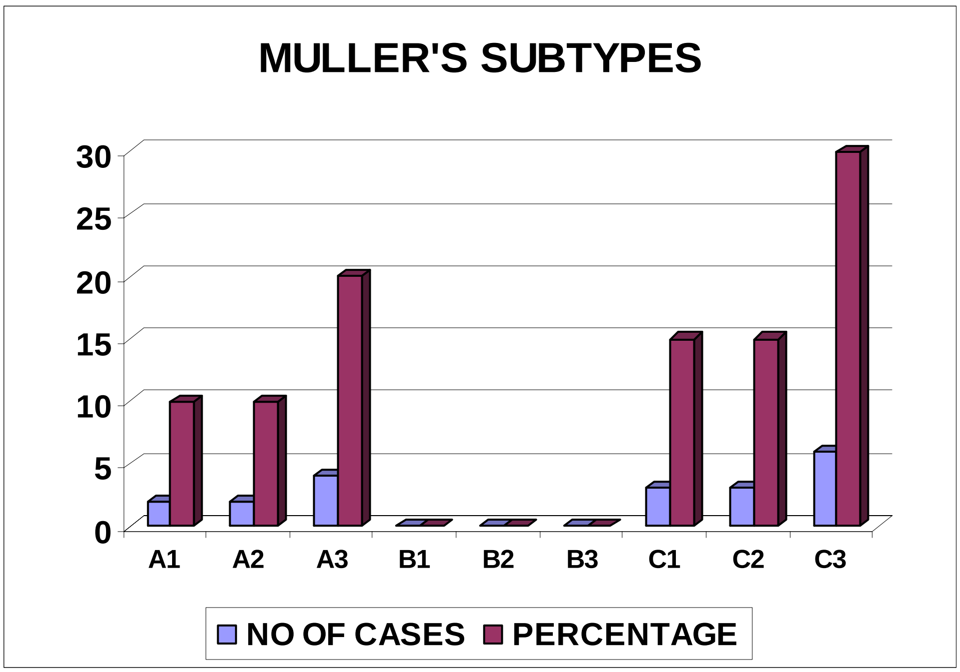


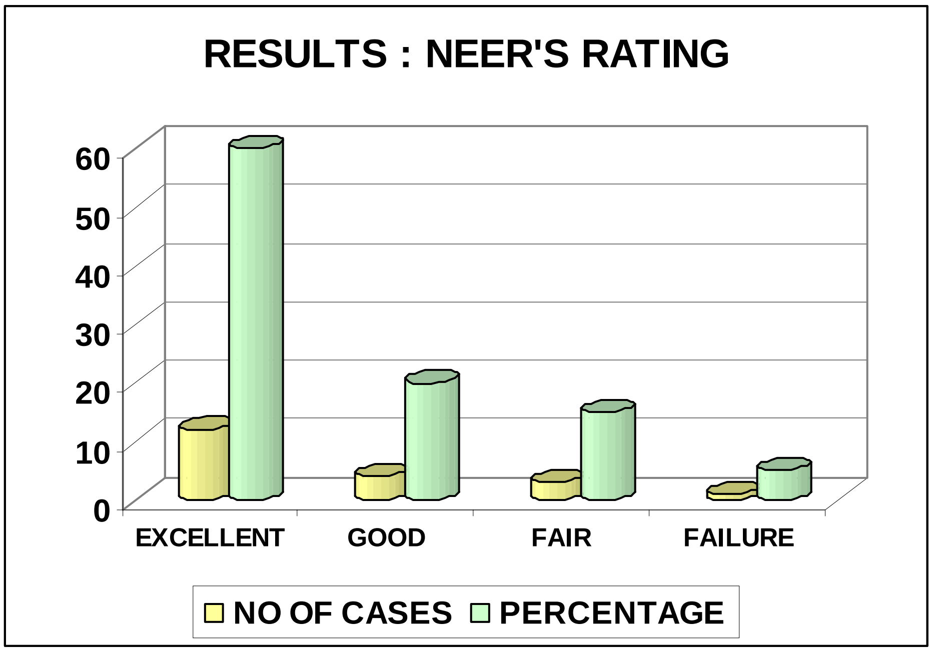
SIDE OF FRACTURE

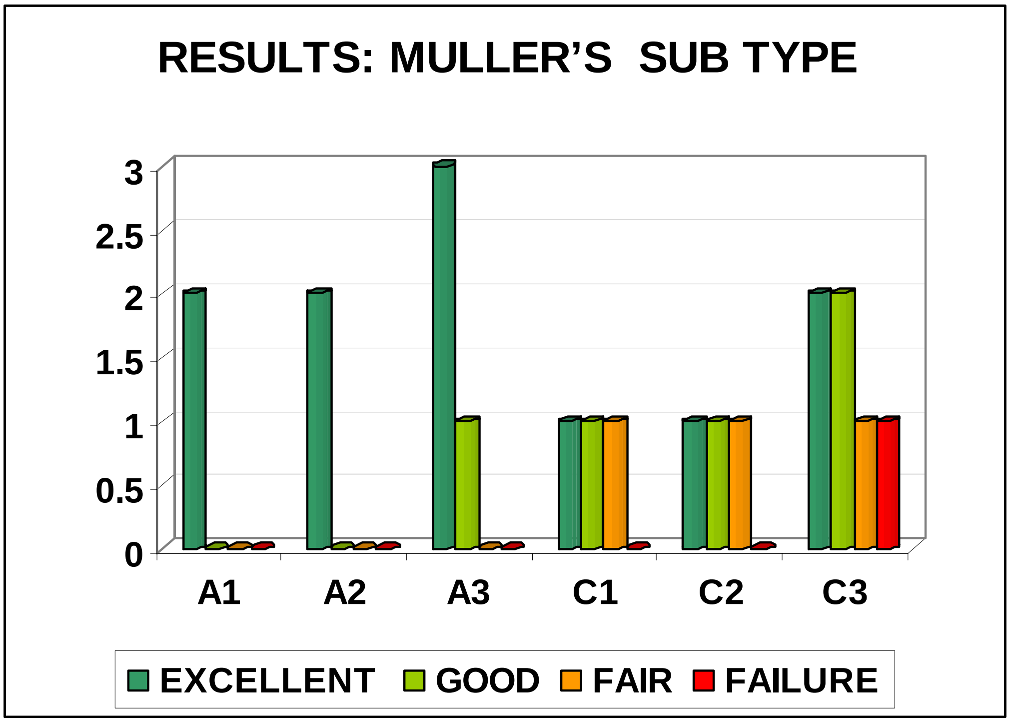


MODE OF INJURY




MULLER'S SUBTYPES
30
25
20
15
10
5
0
A1
A2
A3
B1
B2
B3
C1
C2
C3
NO OF CASES
PERCENTAGE


RESULTS : NEER'S RATING
60
50
40
30
20
10
0
EXCELLENT
GOOD
FAIR
FAILURE
NO OF CASES
PERCENTAGE


RESULTS: MULLER'S SUB TYPE
3
2.5
2
1.5
1
0.5
0
A1
A2
A3
C1
C2
C3
EXCELLENT
GOOD
FAIR
FAILURE

MASTER CHART

S.NO	AGE (Yrs)	SEX	HISTORY	FINDINGS	SIDE	MULLER TYPE	ASS. INJURY	KNEE FLEXION	UNION TIME	COMPLICATIONS	OUTCOME
1	44	FEMALE	RTA	CLOSED FRACTURE	RIGHT	C3	HEAD INJURY	75°	13 Weeks	-	EXCELLENT
2	29	MALE	RTA	CLOSED FRACTURE	RIGHT	C3	-	95°	13 Weeks	-	EXCELLENT
3	32	MALE	RTA	CLOSED FRACTURE	RIGHT	C1	-	120°	12 Weeks	-	EXCELLENT
4	42	MALE	RTA	CLOSED FRACTURE	RIGHT	A3	FRACTURE BOTH BONE LEG ®	130°	12 Weeks	-	EXCELLENT
5	45	MALE	RTA	CLOSED FRACTURE	LEFT	C2	-	80°	11.5 Weeks	-	FAIR
6	36	MALE	RTA	OPEN FRACTURE	LEFT	C3	GALEAZZI FRACTURE DISLOCATION (L)	15°	15 Weeks	SHORTENING 7cm INFECTION	FAILURE
7	23	MALE	RTA	CLOSED FRACTURE	RIGHT	C2	-	90°	11 Weeks	-	GOOD
8	42	MALE	RTA	OPEN FRACTURE	RIGHT	C3	ACETABULUM ® , FRACTURE BOTH BONE LEG ®	30°	14 Weeks	WOUND INFECTION	FAIR
9	19	MALE	RTA	CLOSED FRACTURE	RIGHT	C2	-	100°	12 Weeks	-	EXCELLENT
10	49	MALE	Acc. FALL	CLOSED FRACTURE	RIGHT	A2	-	115°	11 Weeks	-	EXCELLENT
11	62	MALE	Acc. FALL	CLOSED FRACTURE	RIGHT	A1	-	85°	13 Weeks	-	EXCELLENT
12	61	MALE	RTA	CLOSED FRACTURE	RIGHT	C3	-	90°	12 Weeks	-	GOOD
13	66	MALE	RTA	CLOSED FRACTURE	RIGHT	A3	-	110°	11 Weeks	MAL UNION	GOOD
14	48	FEMALE	RTA	CLOSED FRACTURE	LEFT	A3	-	100°	11.5 Weeks	-	EXCELLENT

15	59	FEMALE	Acc. FALL	CLOSED FRACTURE	LEFT	A2	-	100°	13 Weeks	-	EXCELLENT
16	51	MALE	RTA	CLOSED FRACTURE	RIGHT	C1	-	80°	10.5 Weeks	-	FAIR
17	58	MALE	RTA	CLOSED FRACTURE	RIGHT	C1	FRACTURE BOTH BONE LEG ®	70°	12 Weeks	-	GOOD
18	56	MALE	RTA	CLOSED FRACTURE	RIGHT	A3	-	120°	11 Weeks	-	EXCELLENT
19	54	MALE	RTA	CLOSED FRACTURE	RIGHT	C3	HEAD INJURY	70°	13.5 Weeks	SUPERFICIAL WOUND INFECTION	GOOD
20	47	FEMALE	Acc. FALL	CLOSED FRACTURE	RIGHT	A1	-	120°	10 Weeks	-	EXCELLENT

RTA - ROAD TRAFFIC ACCIDENT
ACC.FALL - ACCIDENTAL TRIVIAL FALL